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(D)OMI NO₂: the KNMI near-real time product

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Folkert Boersma, EOS Aura Meeting, 8 november 2005

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Contents

- Purpose and context
- Near real-time retrieval algorithm
- Results
- Validation

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Purpose (1)

- To provide users with near-real time air pollution monitoring
- Users include:
 - environmental agencies
 - air quality forecasters
 - GEMS (EU GMES) lead by ECMWF
 - PROMOTE (ESA GMES)
 - ...

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Purpose 2

To generate a long-term consistent dataset from:

- GOME (1996-2003)
- SCIAMACHY (2003-)
- OMI (2004-)

KNMI retrieval algorithm for tropospheric NO₂

- Data publicly available via www.temis.nl
- Described in Boersma et al. (*JGR*, D04311, 2004)
- Lightning NO₂ production (*ACP*, **5**, 2005)

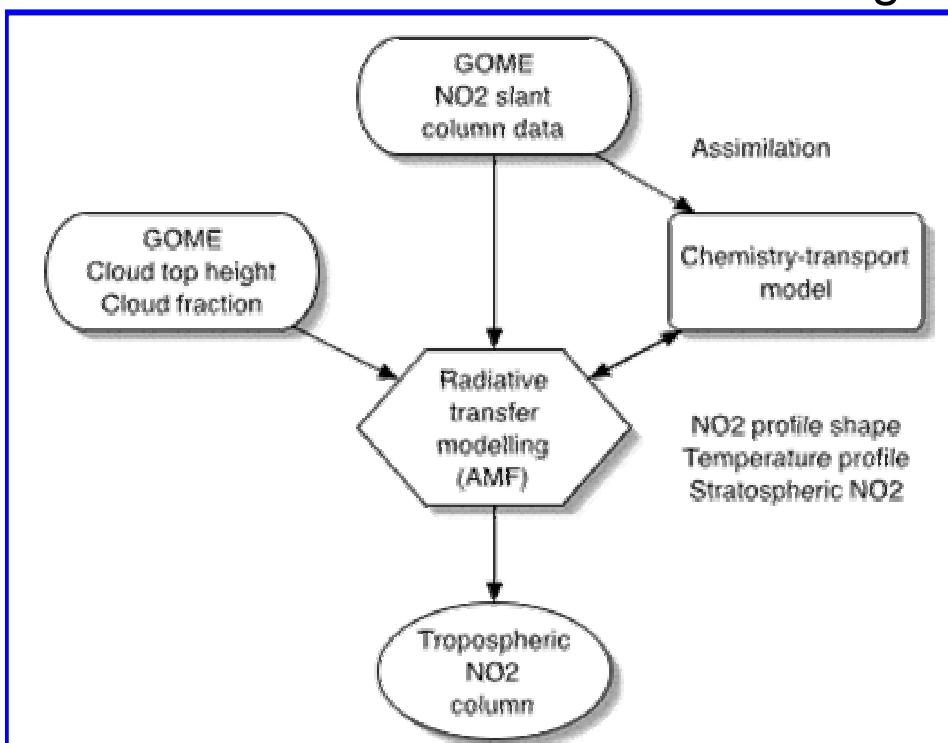
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Near real time retrieval algorithm

Post-processing (GOME/SCIA)

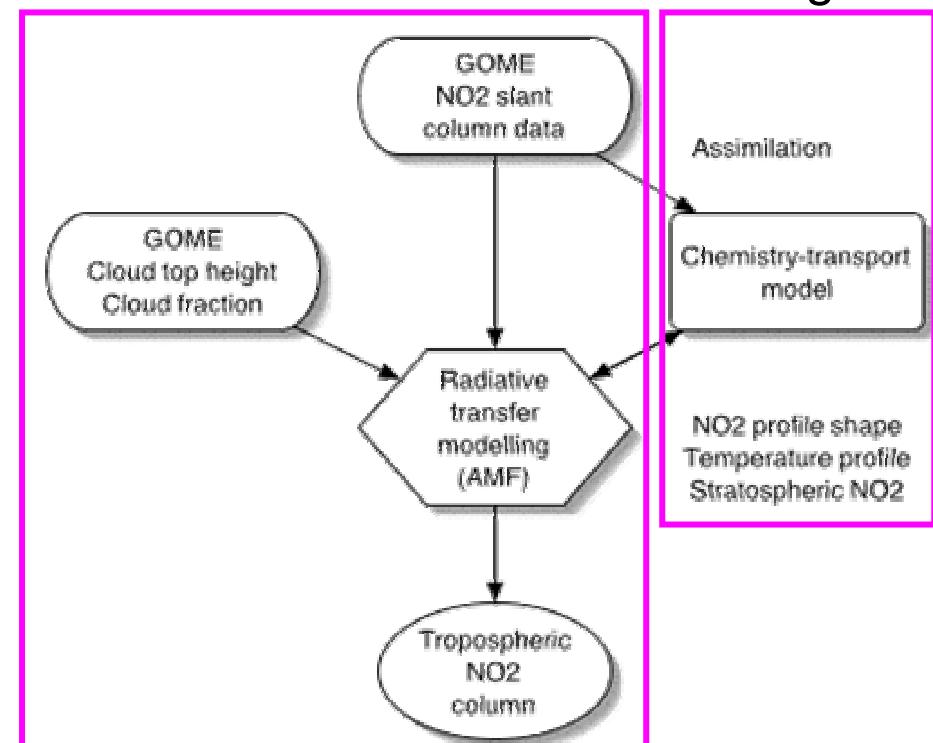
Retrieval/assimilation/modelling



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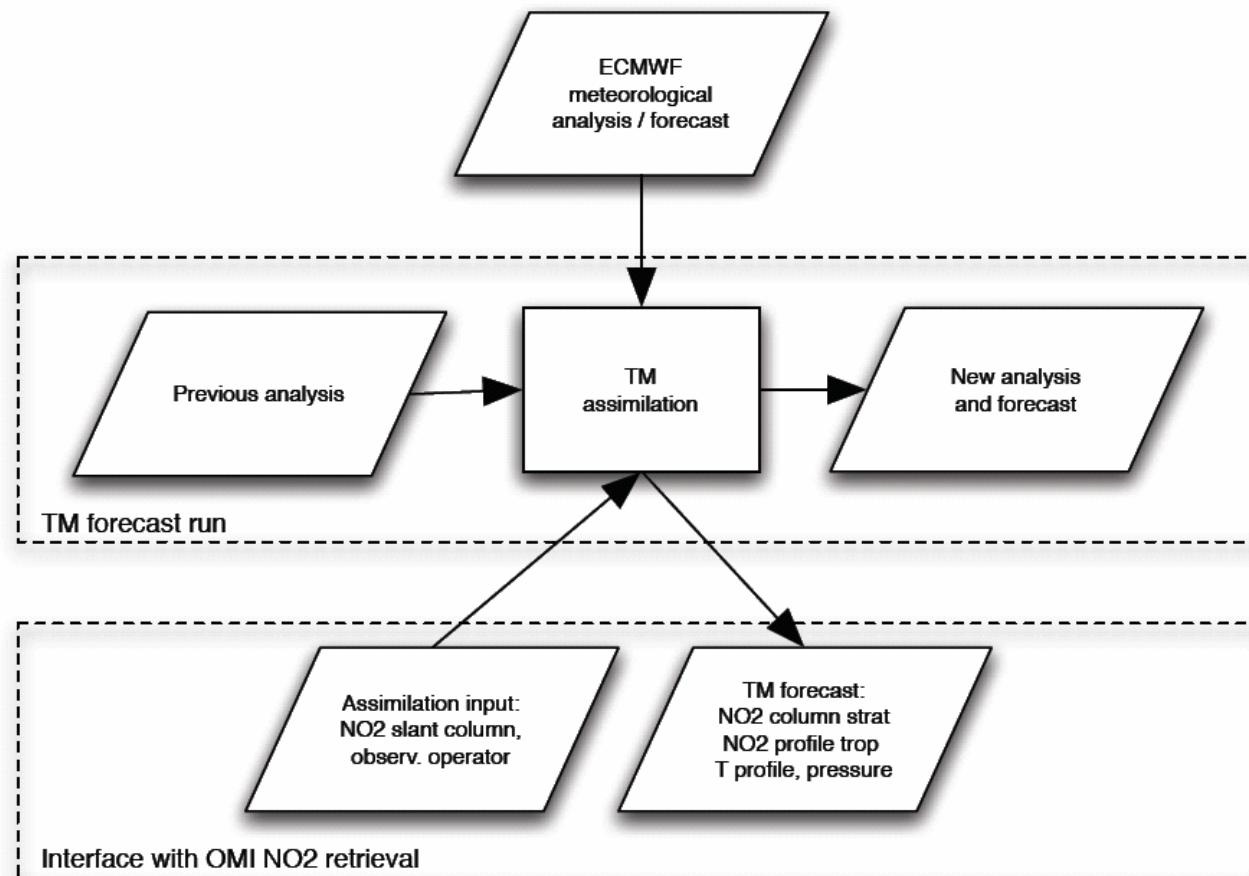
NRT (OMI)

Retrieval + assimilation/modelling



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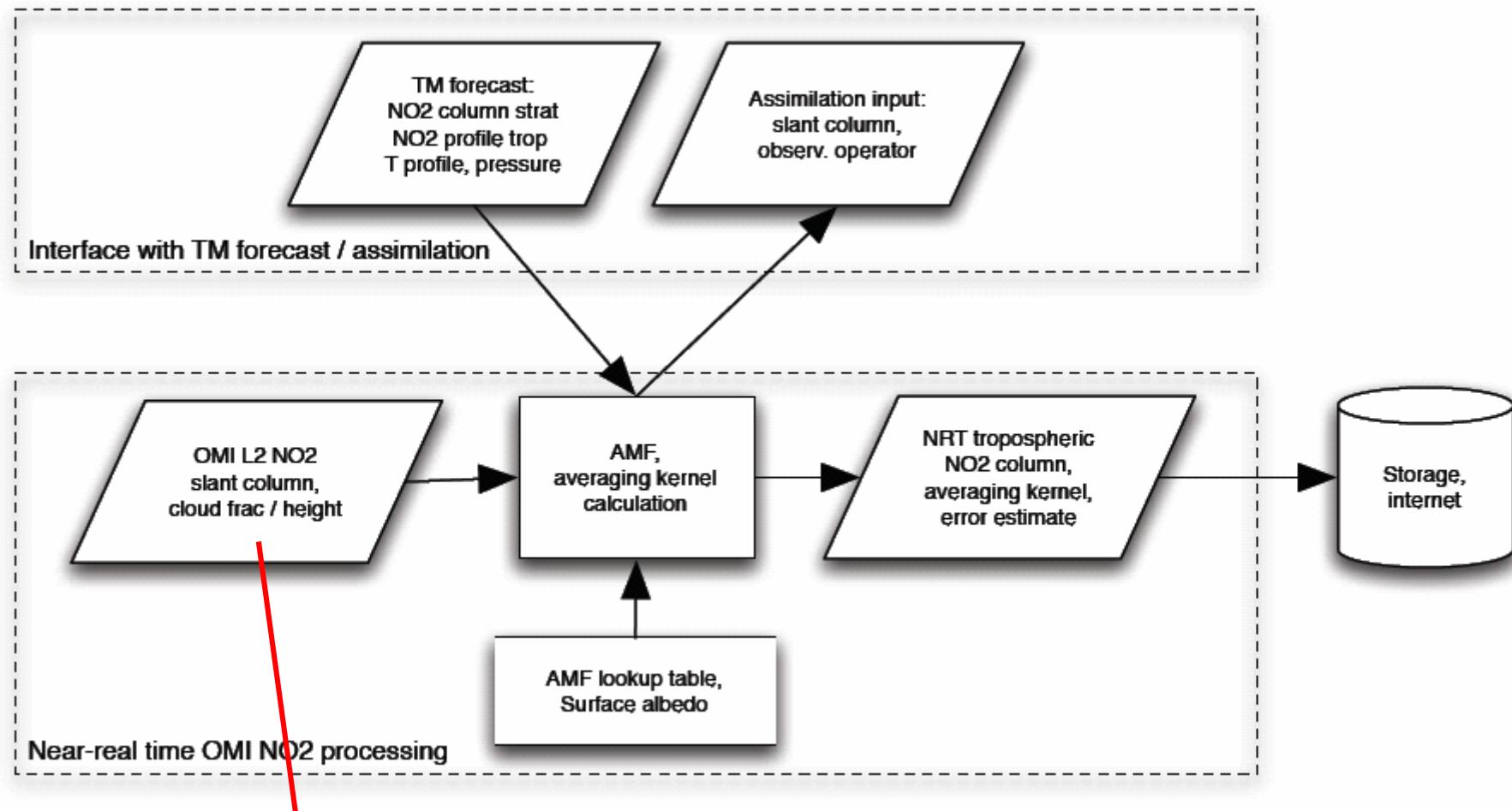
Branch 1: TM4 forecast



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Branch 2: NRT retrieval



•••• NASA/KNMI DOAS algorithm

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NRT retrieval ‘operational’ since 7 October 2005

Images available within ~2hrs (www.temis.nl/airpollution/)

- data acquisition
 - downlink
 - processing
 - KNMI/NASA DOAS algorithm
-

~2 hrs

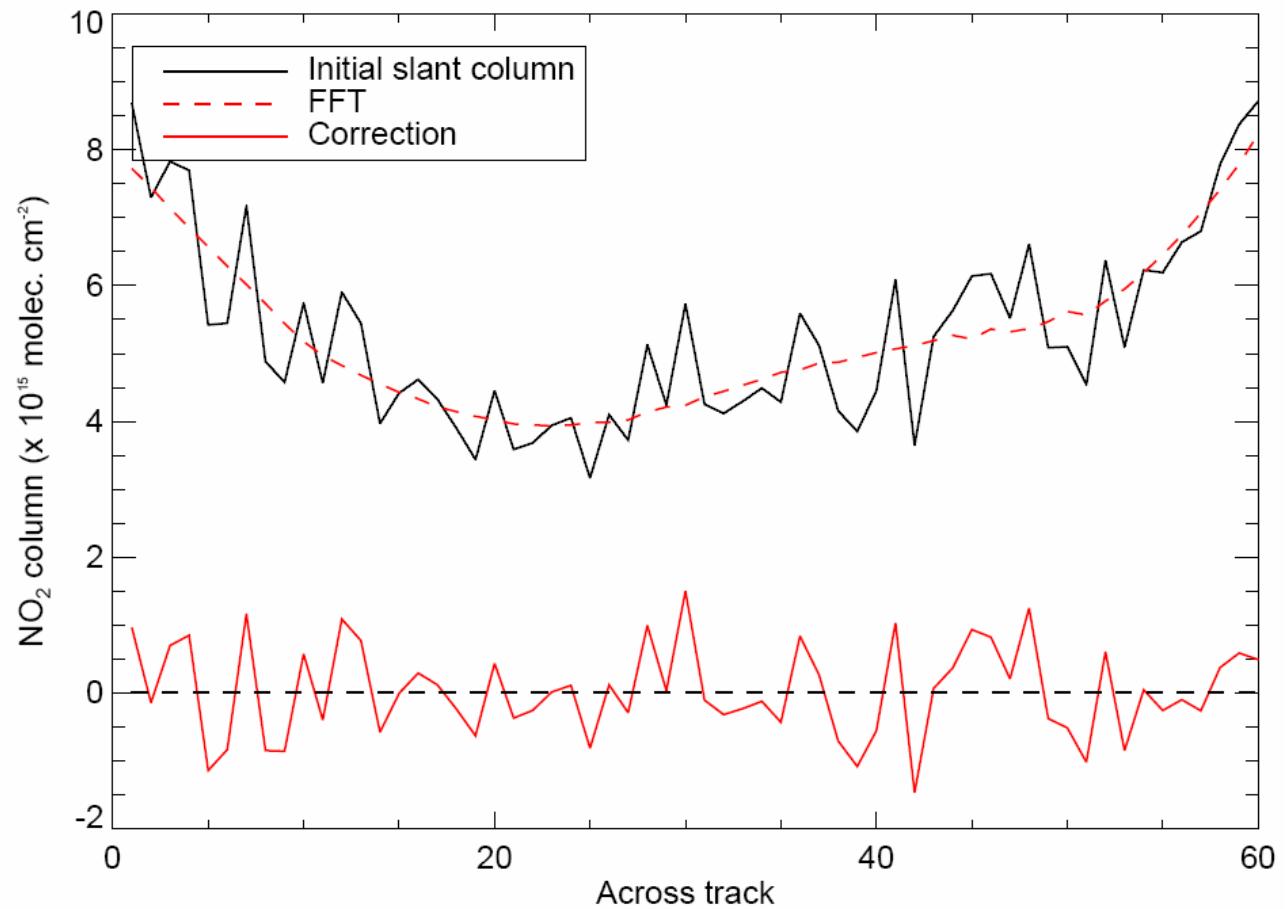
- NRT processing time: < 2 minutes

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Stripe correction

1. Find window with smallest variation in initial columns
2. Compute mean column vs. across track viewing angle
3. FFT analysis to smooth

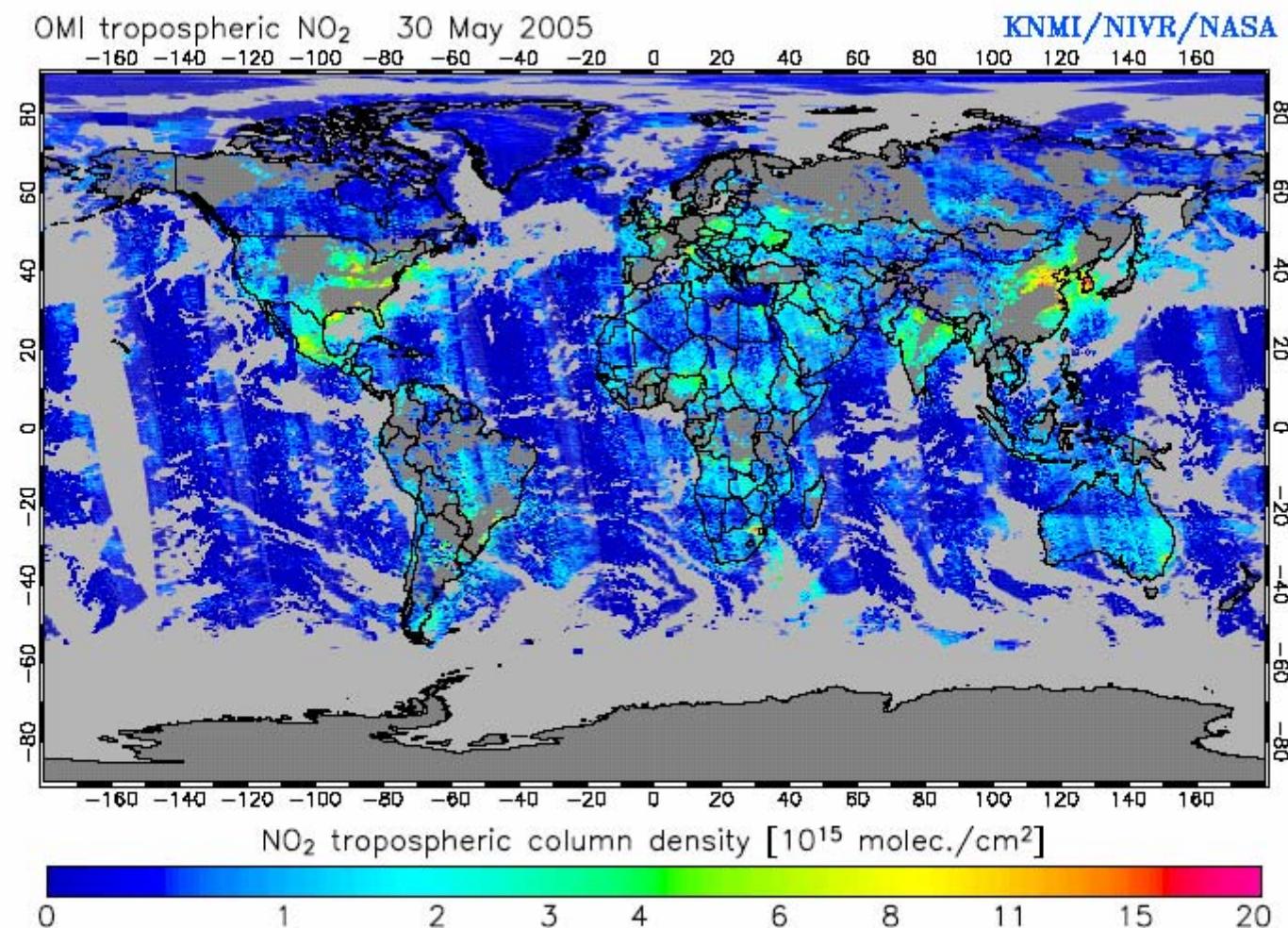


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Stripe correction



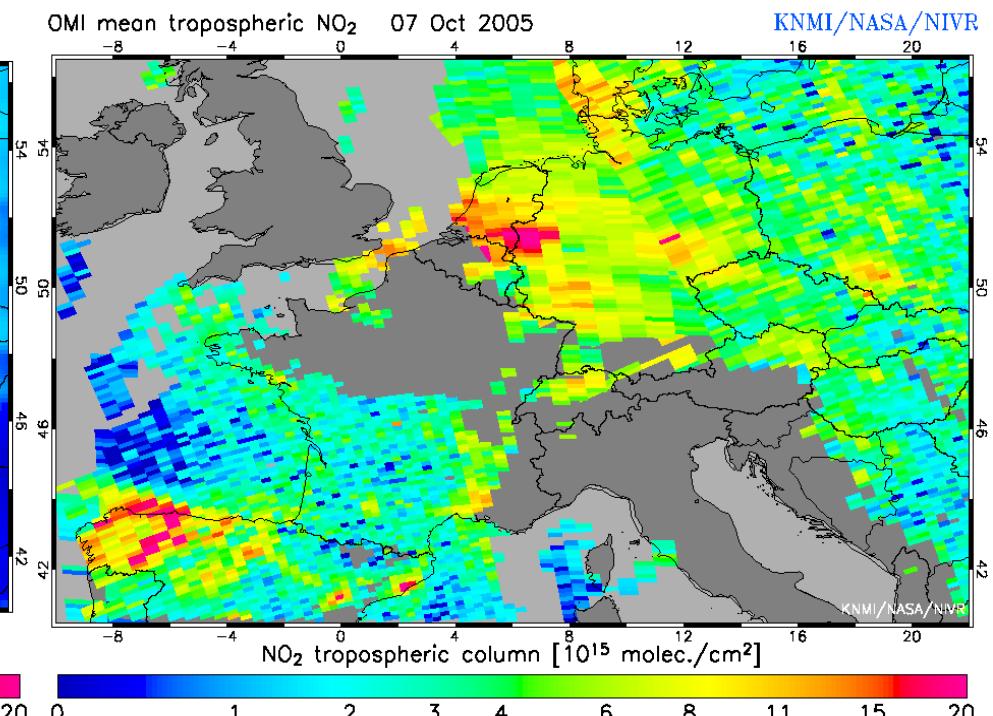
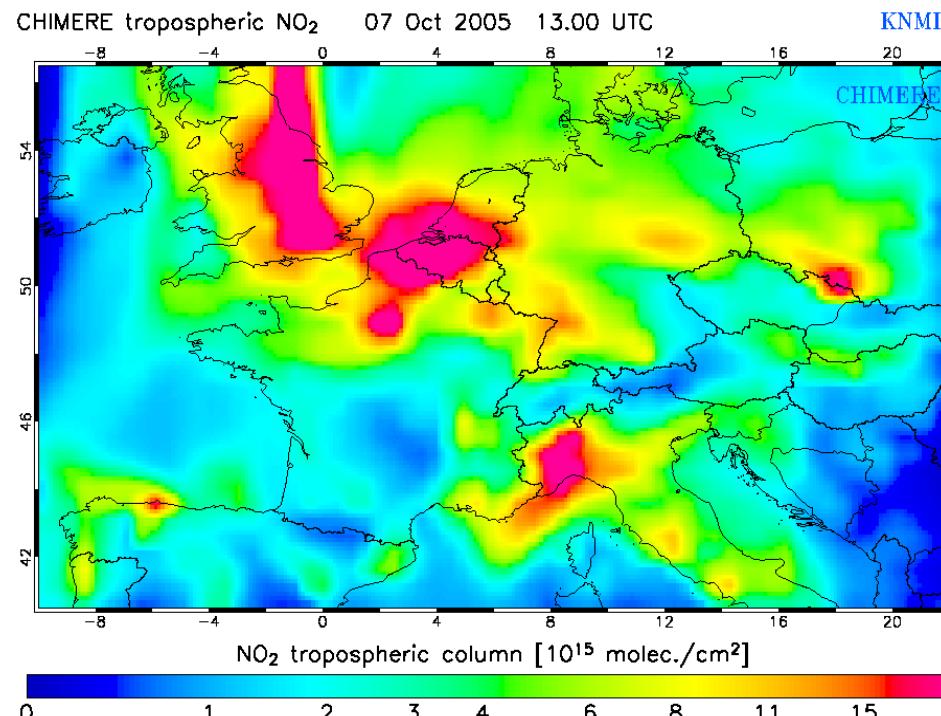
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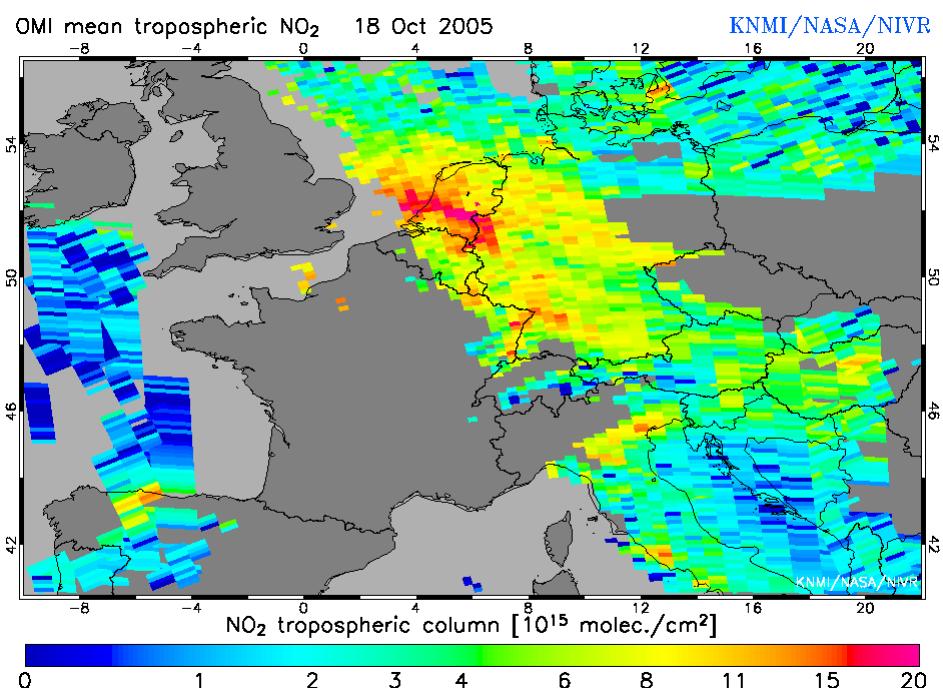
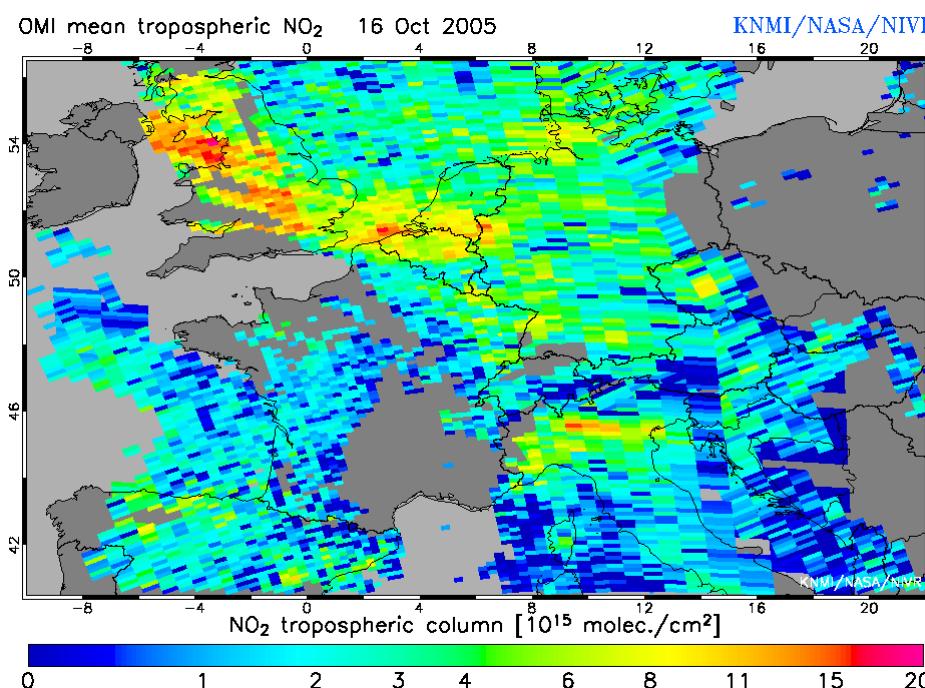
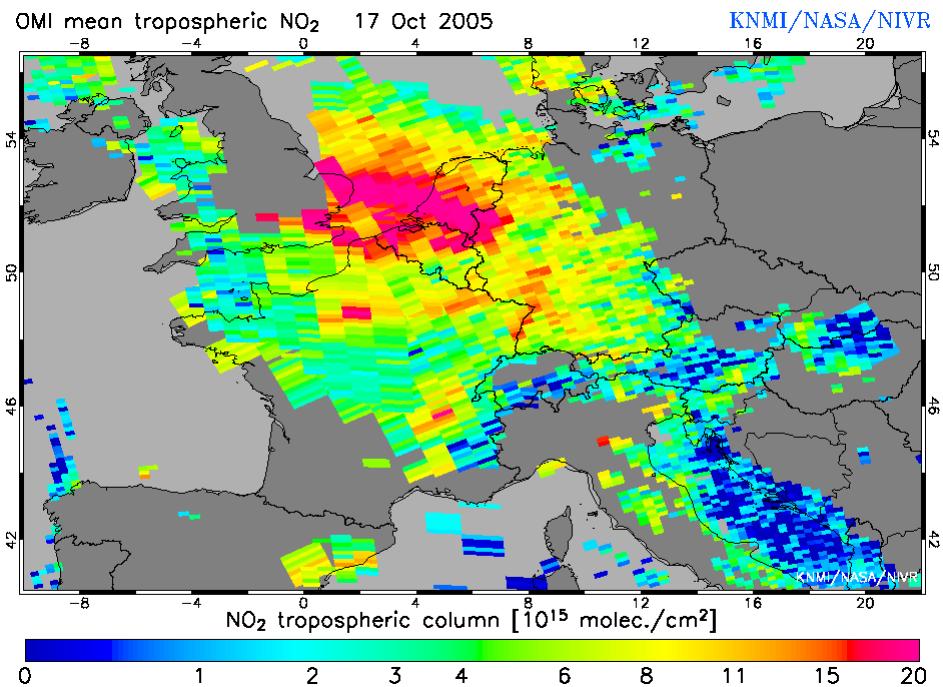
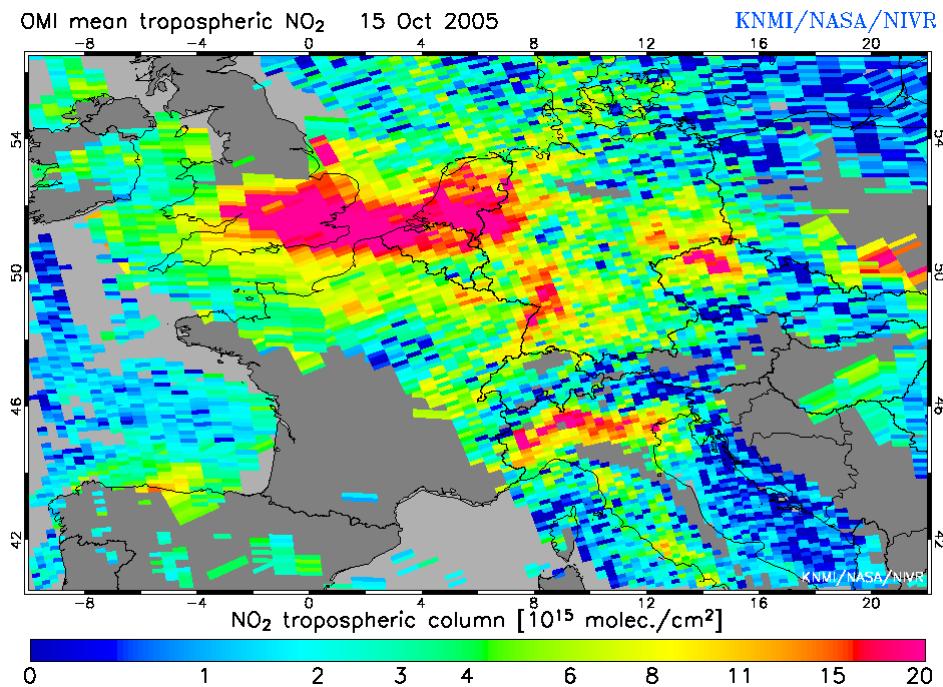


Comparison with CHIMERE

Cloudy pixels masked

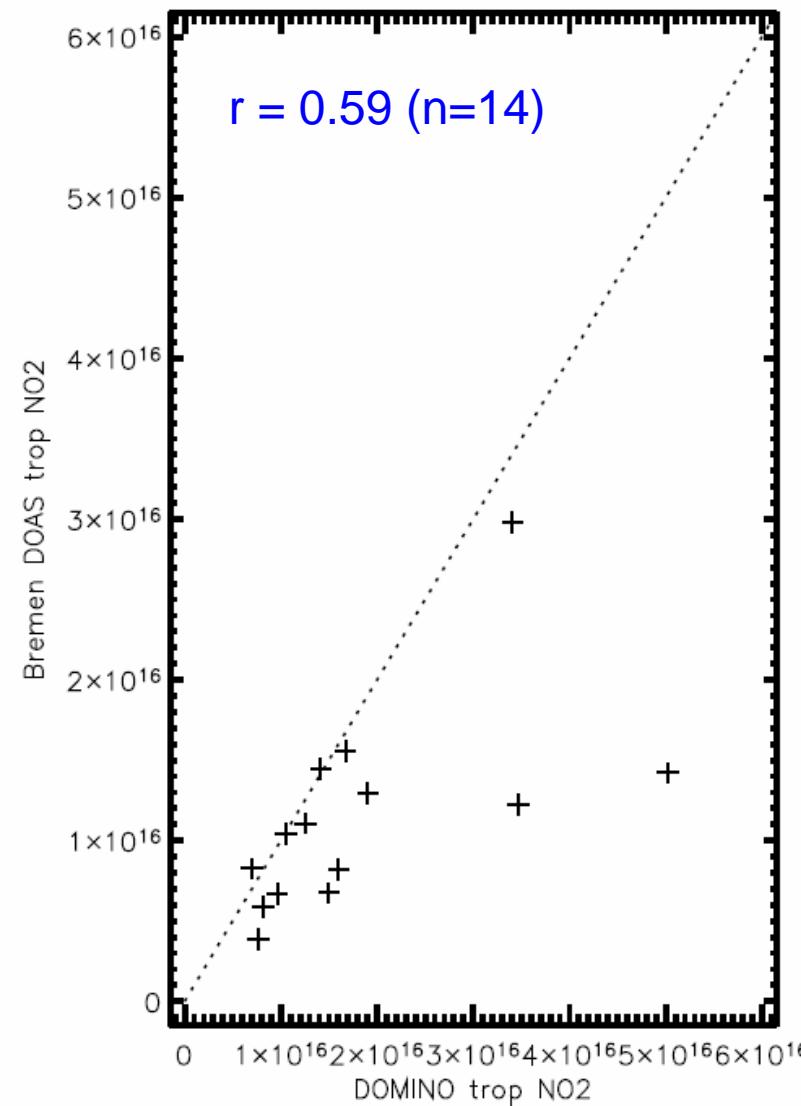
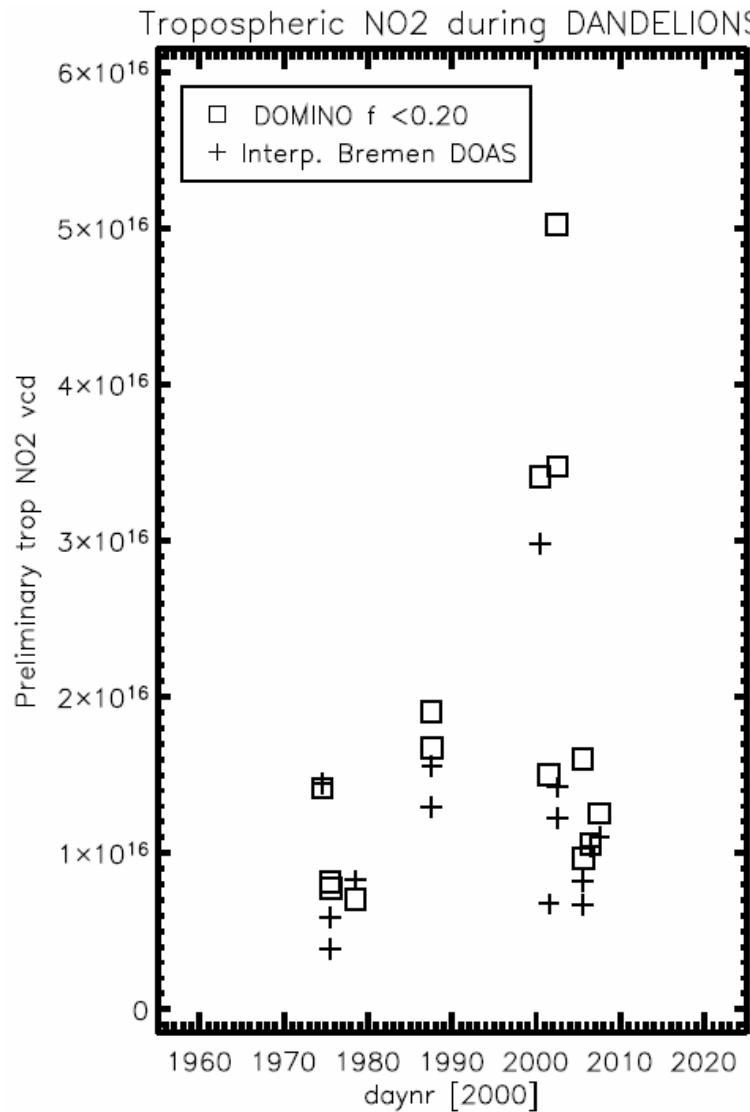


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Dandelions validation (in progress)



- 14 separate orbits
- DOMINO > MAXDOAS
- Representativity issues

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Conclusions

- OMI NO₂ near-real time retrieval operational
- Initial comparisons to:
 - CHIMERE
 - MAXDOAS

Outlook

- Validation vs. SCIAMACHY and official OMI NO₂ product
 - clouds
 - stripe correction

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1. ‘Rural’ comparison

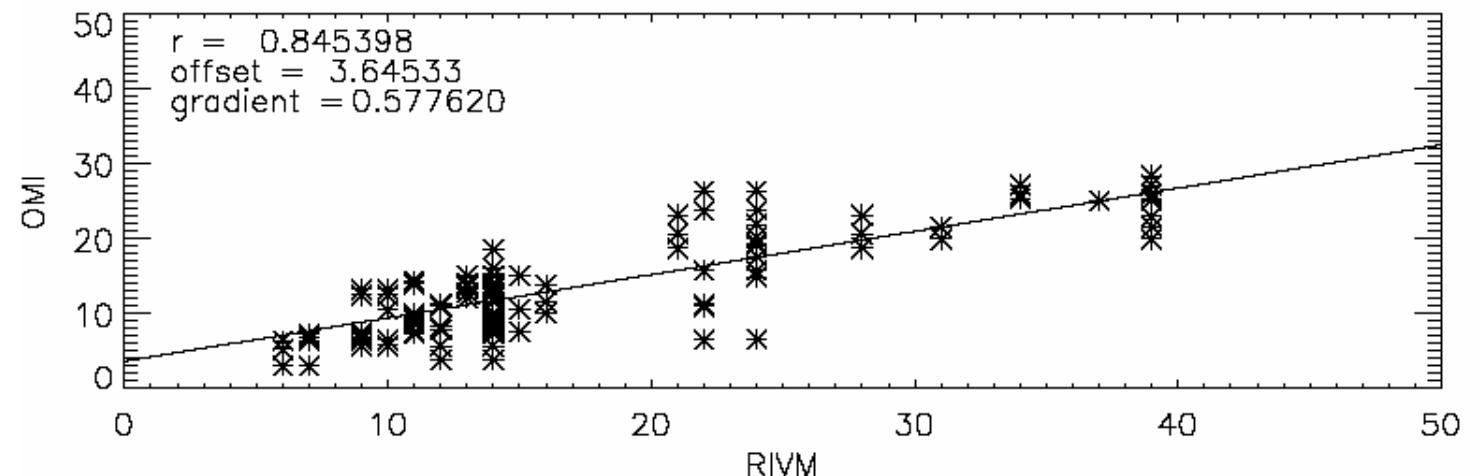
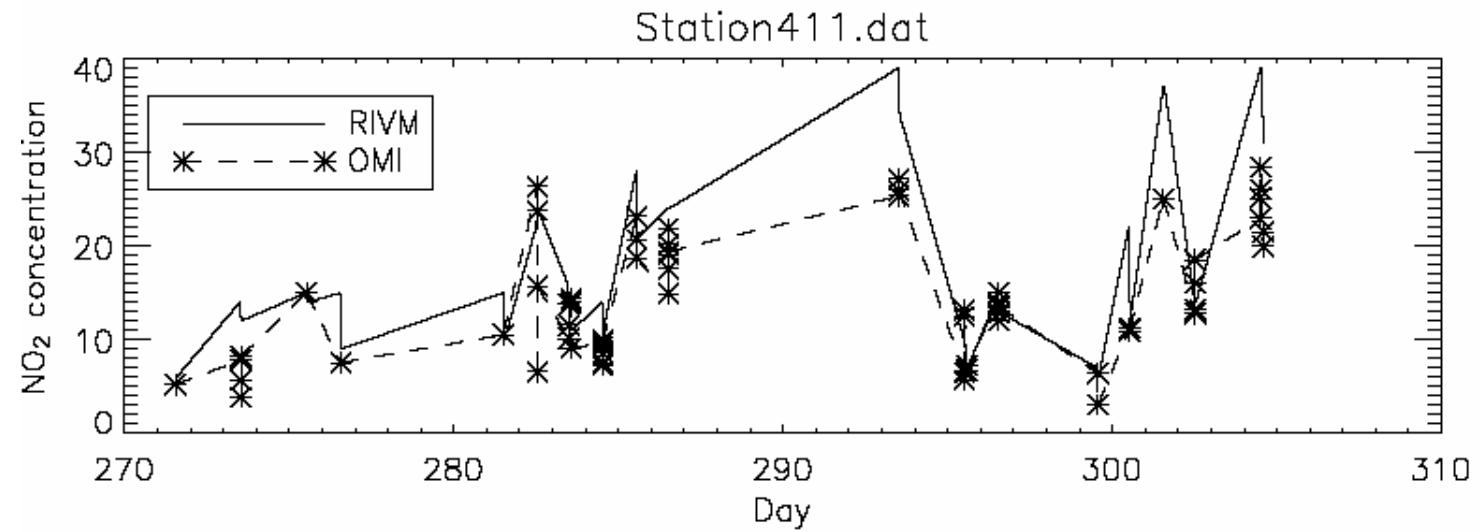
Criteria

- OMI pixel w<50% ($f_{cl} < 0.2$)
- $|\Delta t| < 1$ hr
- $|\Delta r| < 25$ km

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'Rural' comparison – Schipluiden

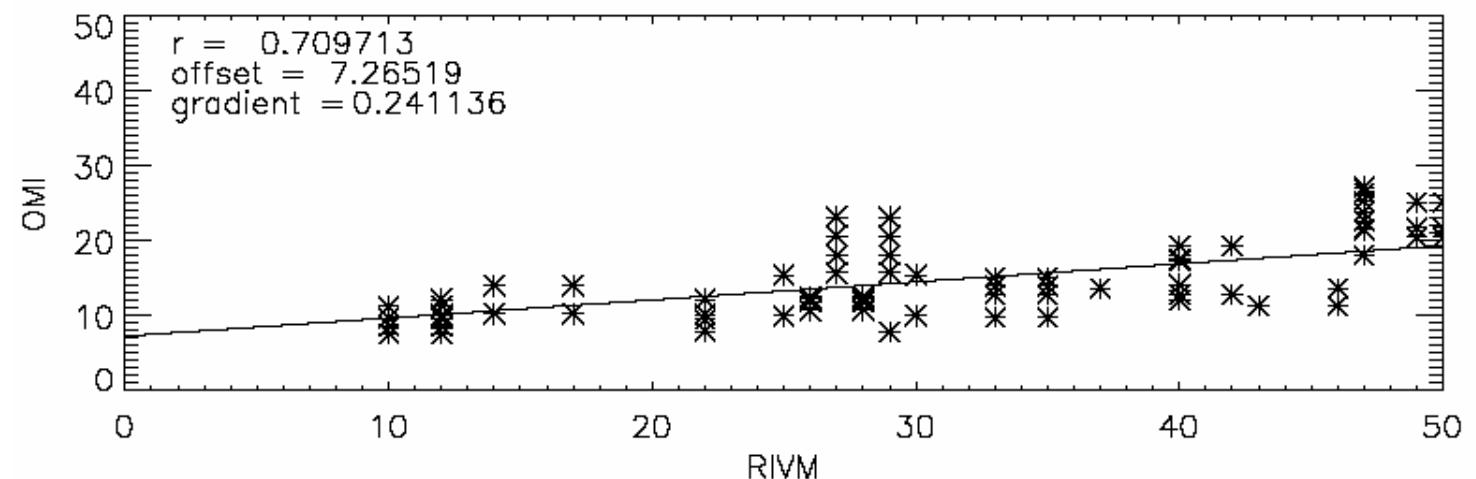
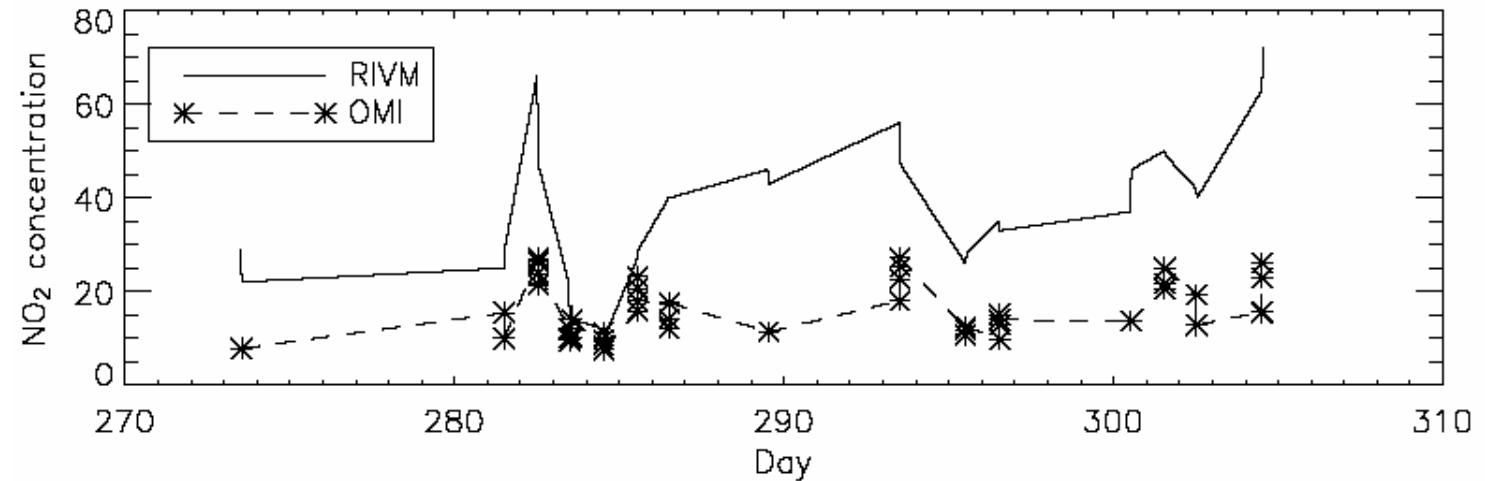


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'Rural' comparison – Westmaas

Station437.dat

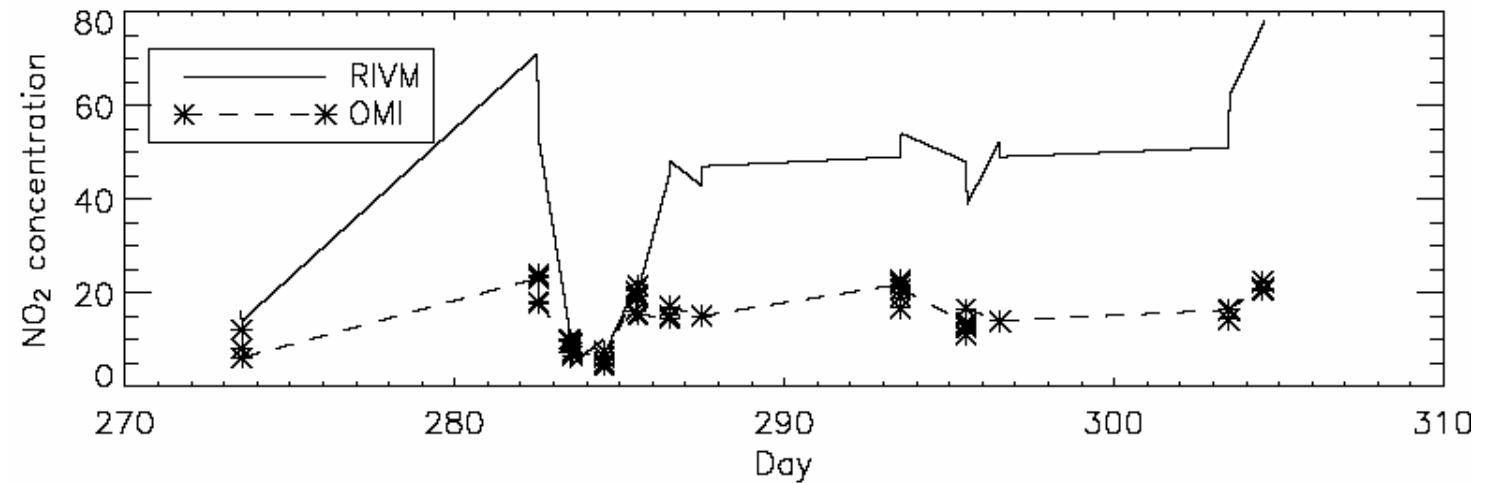


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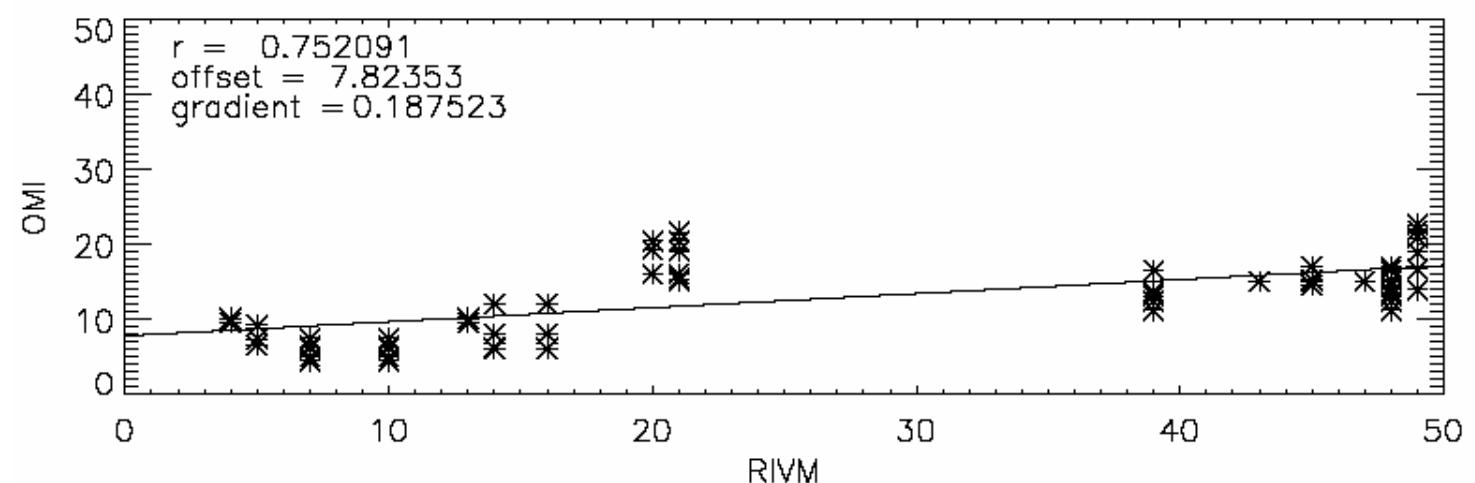
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'Rural' comparison – Cabauw

Station620.dat



$r = 0.752091$
offset = 7.82353
gradient = 0.187523

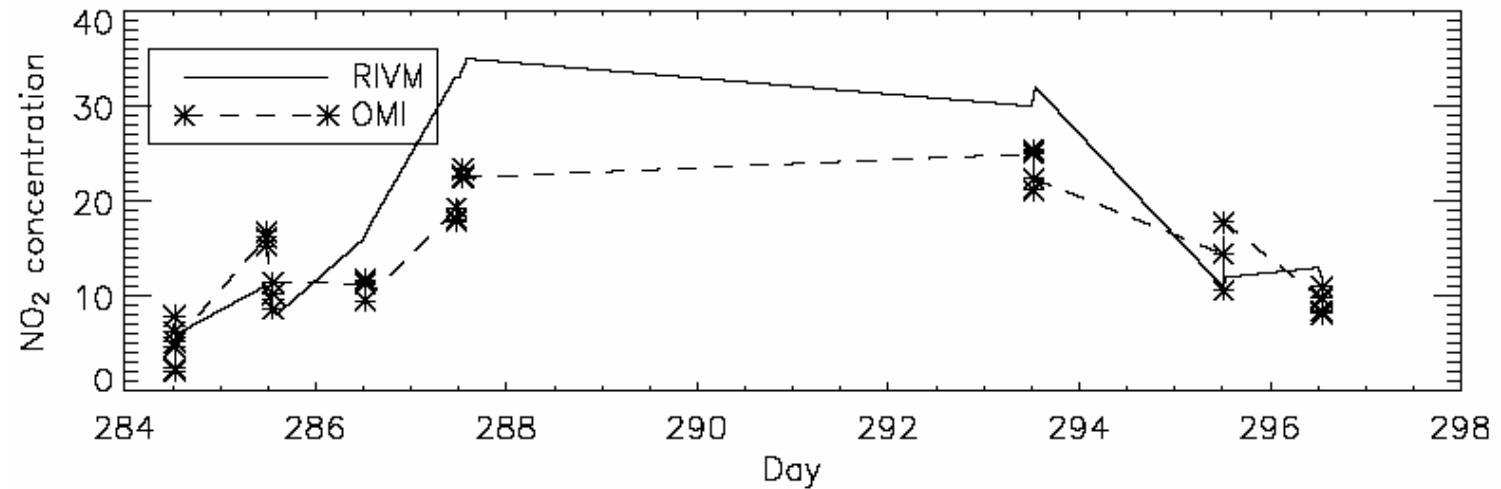


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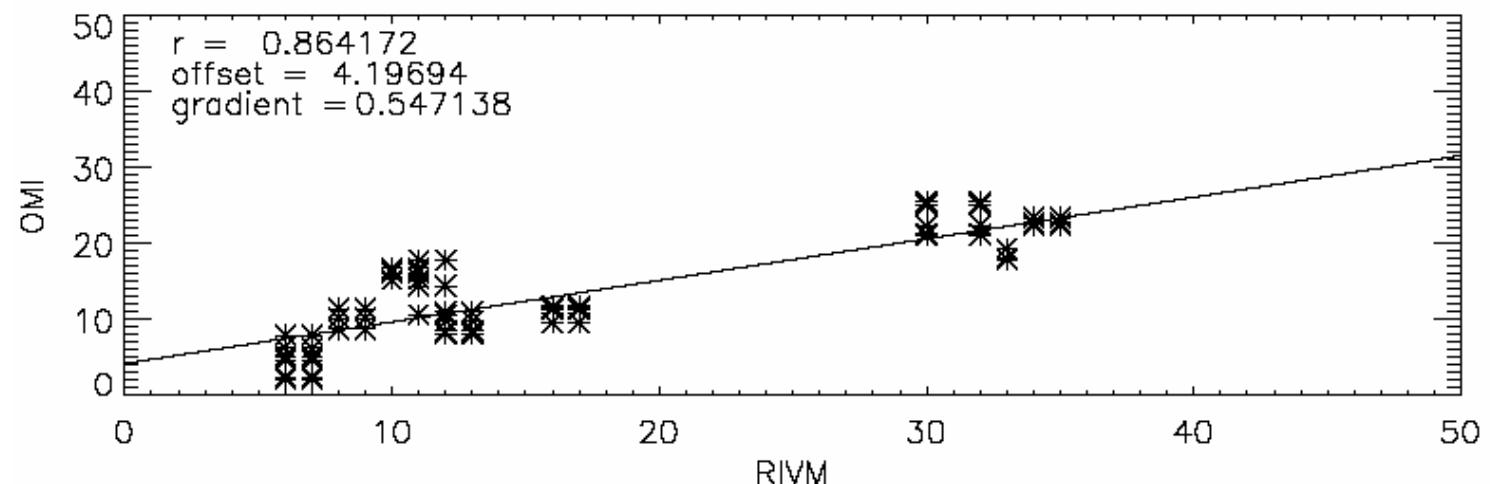
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'Rural' comparison – Hellendoorn

Station807.dat



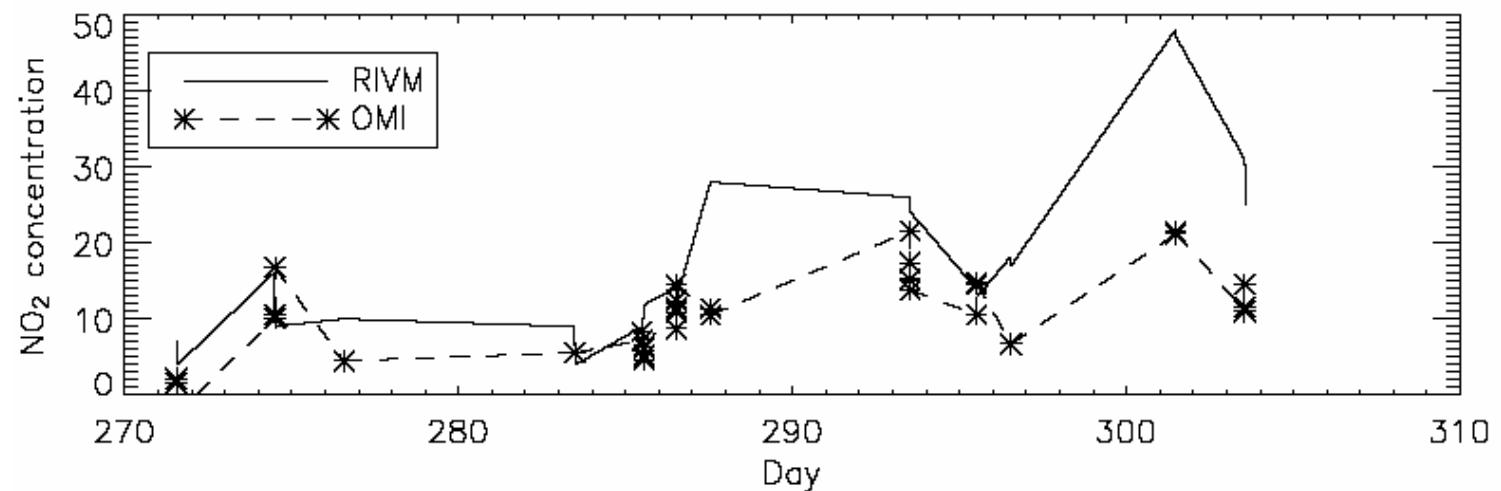
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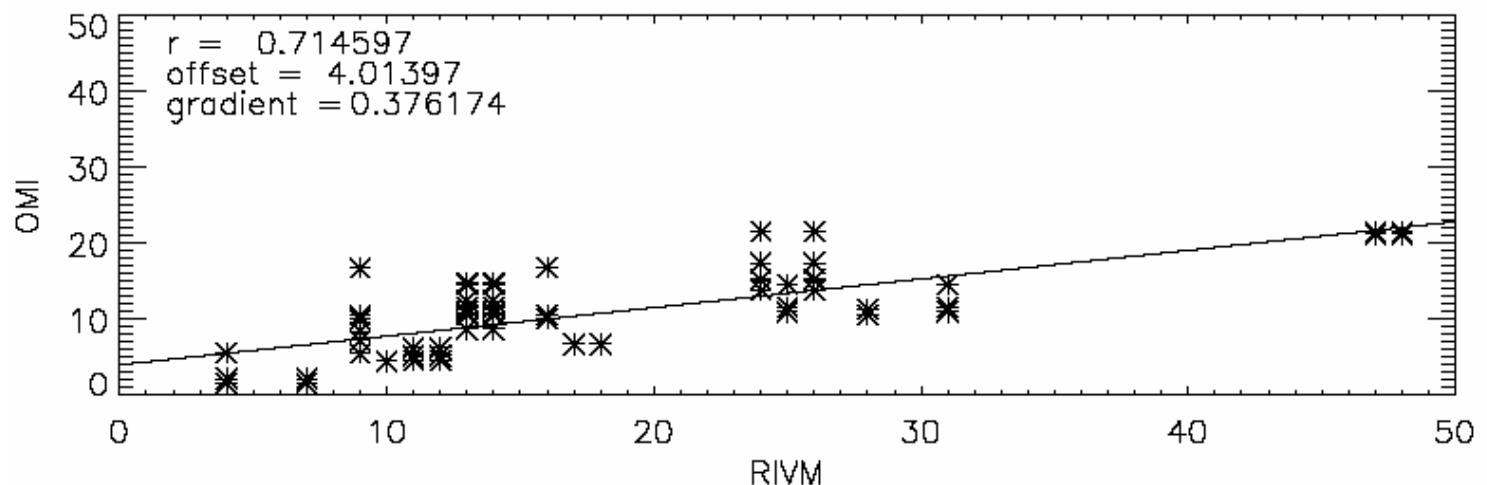
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'Rural' comparison – Kollumerwaard

Station934.dat



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'Rural' comparison

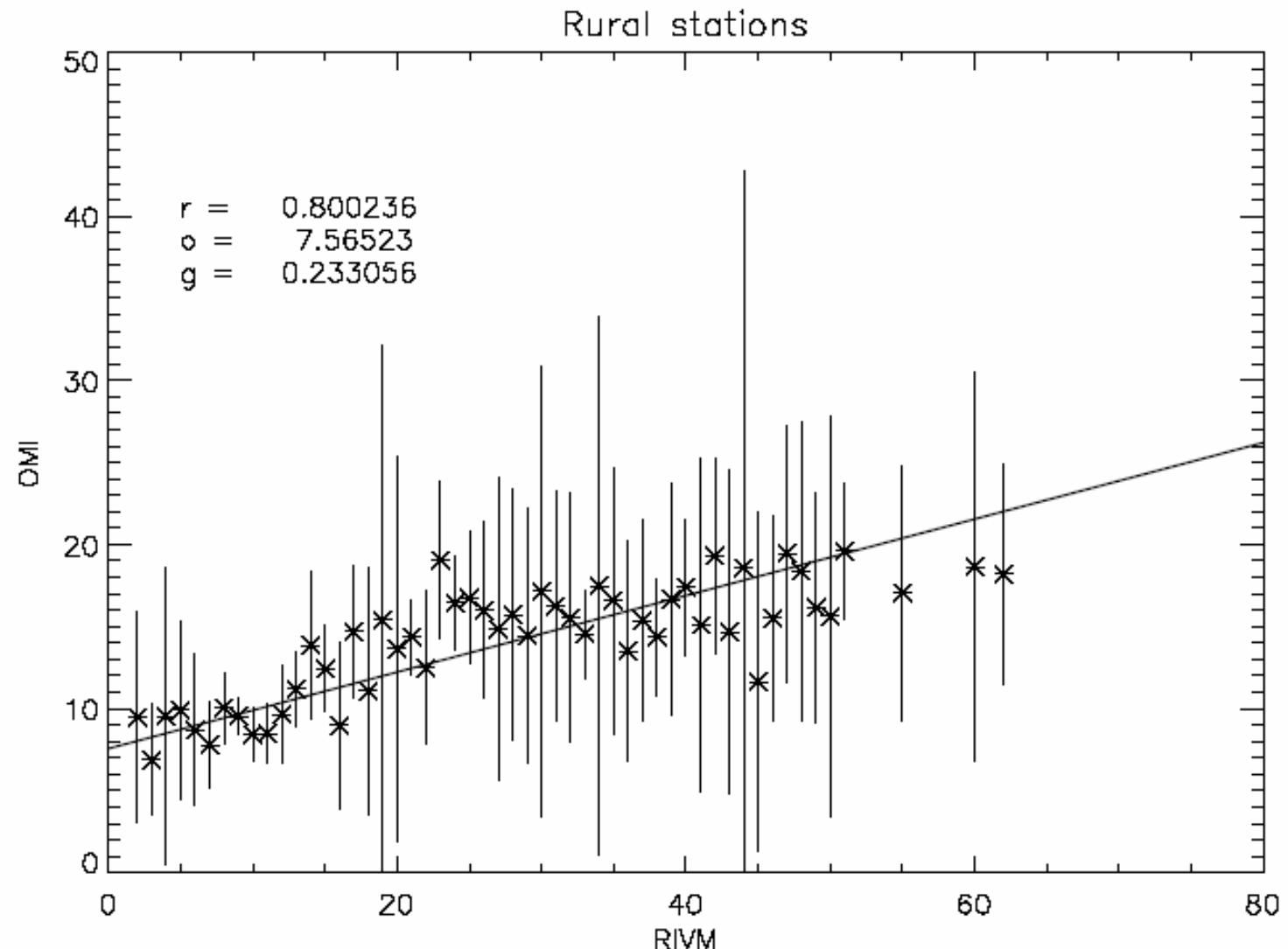
All stations (>20)

- Calculate average OMI column for corresponding to surface concentrations
- Standard deviation of the mean is a measure for uncertainty on OMI average
- Calculate correlation coefficient
- Calculate weighted least square fit $y = a + bx$

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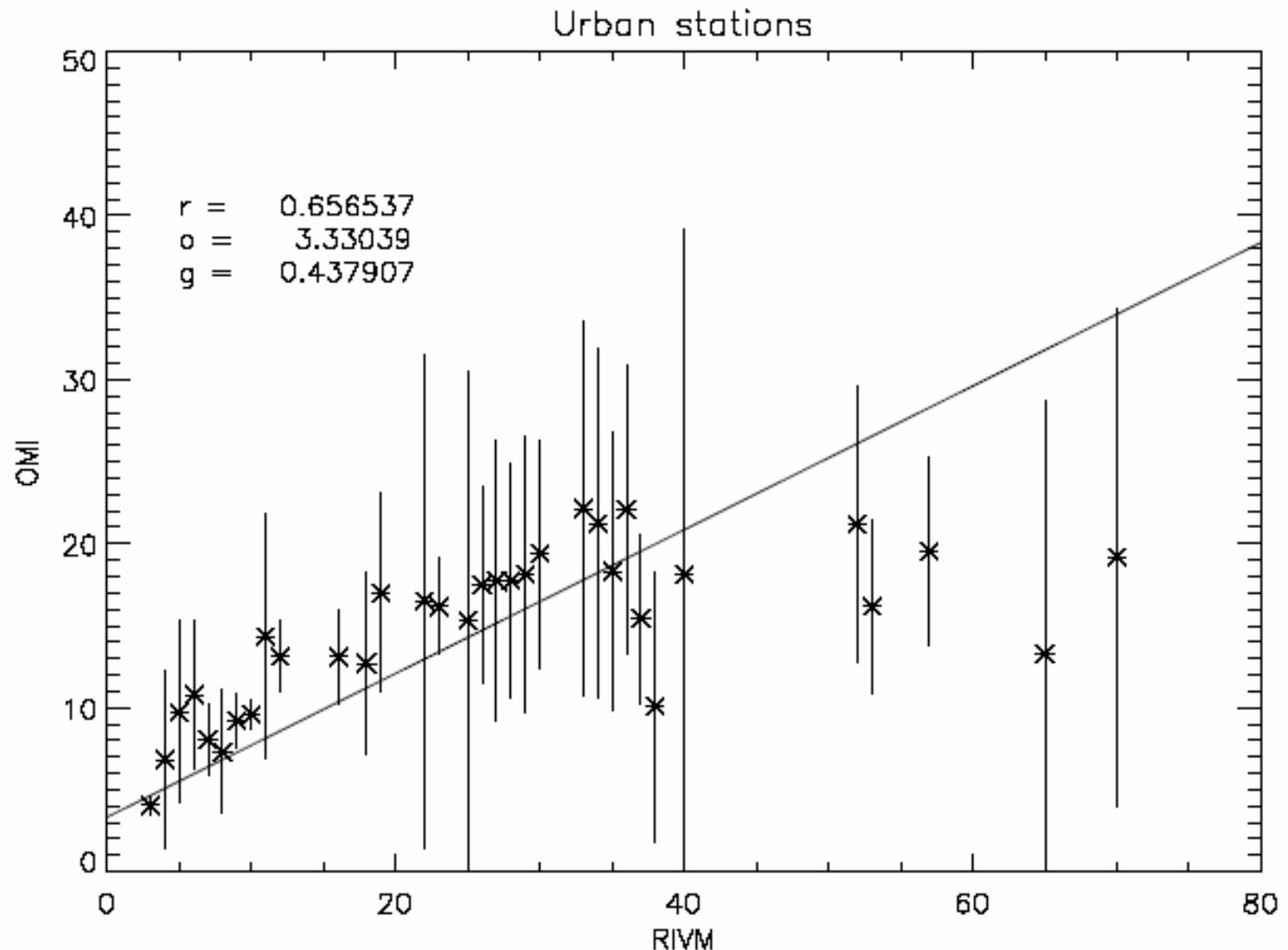
'Rural' comparison



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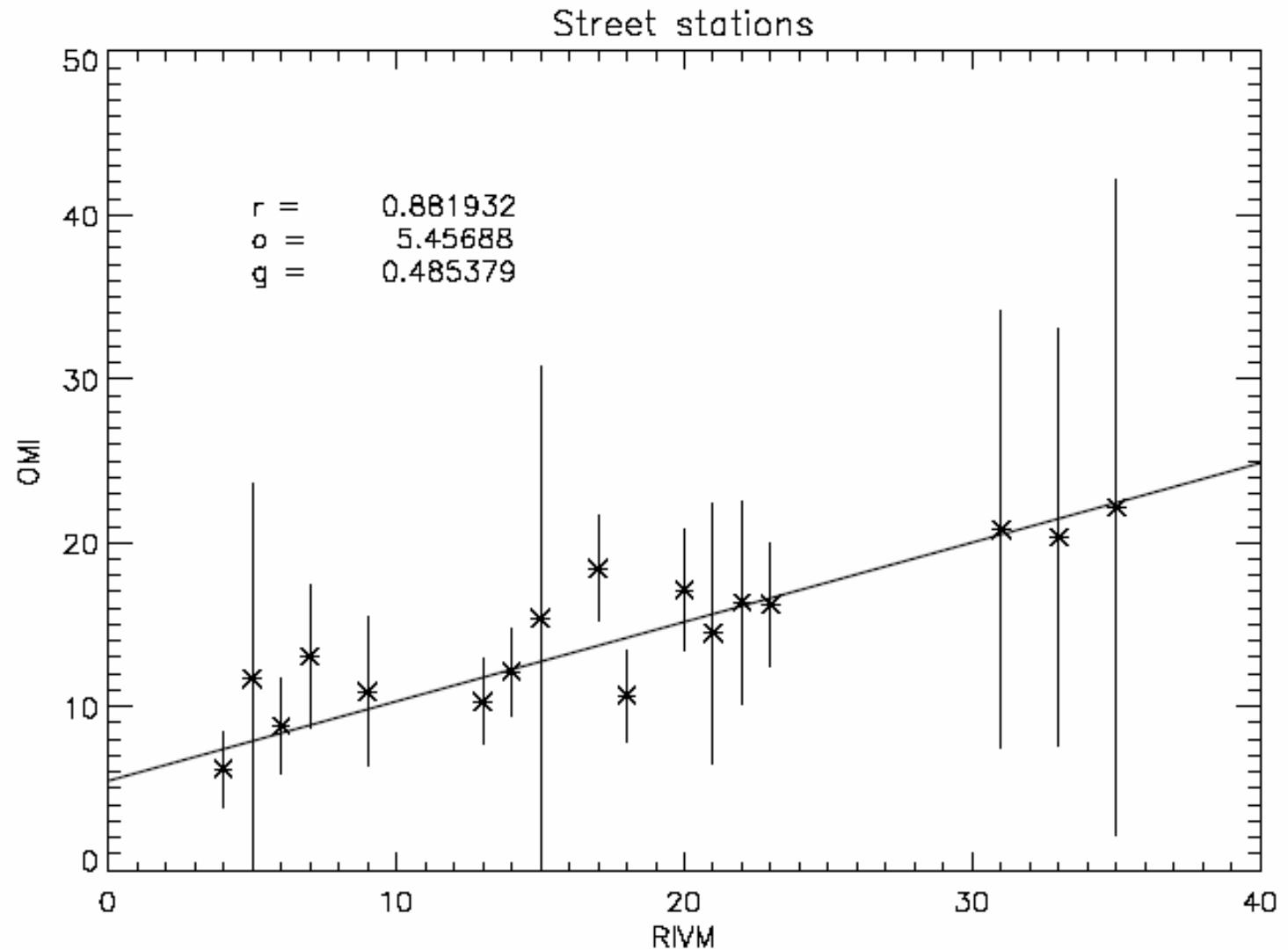
'Urban' comparison



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Street station comparison



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Preliminary conclusions

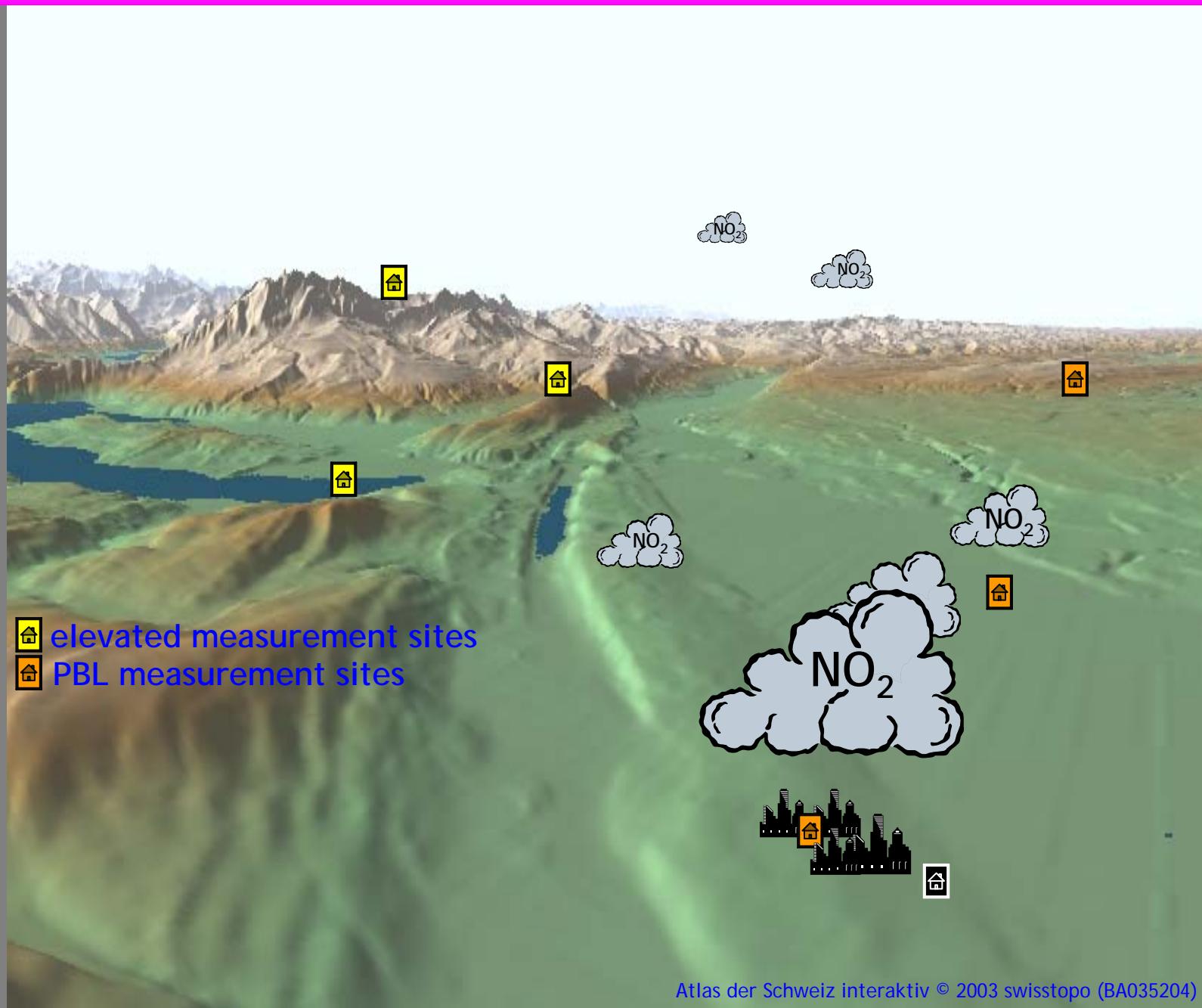
- First (Dutch) OMI NO₂ ‘validation’ result of ‘old’
- For NL: good average correlations ($r= 0.6-0.9$)
- Clear relationship between surface NO₂ conc. and OMI columns

Discussion

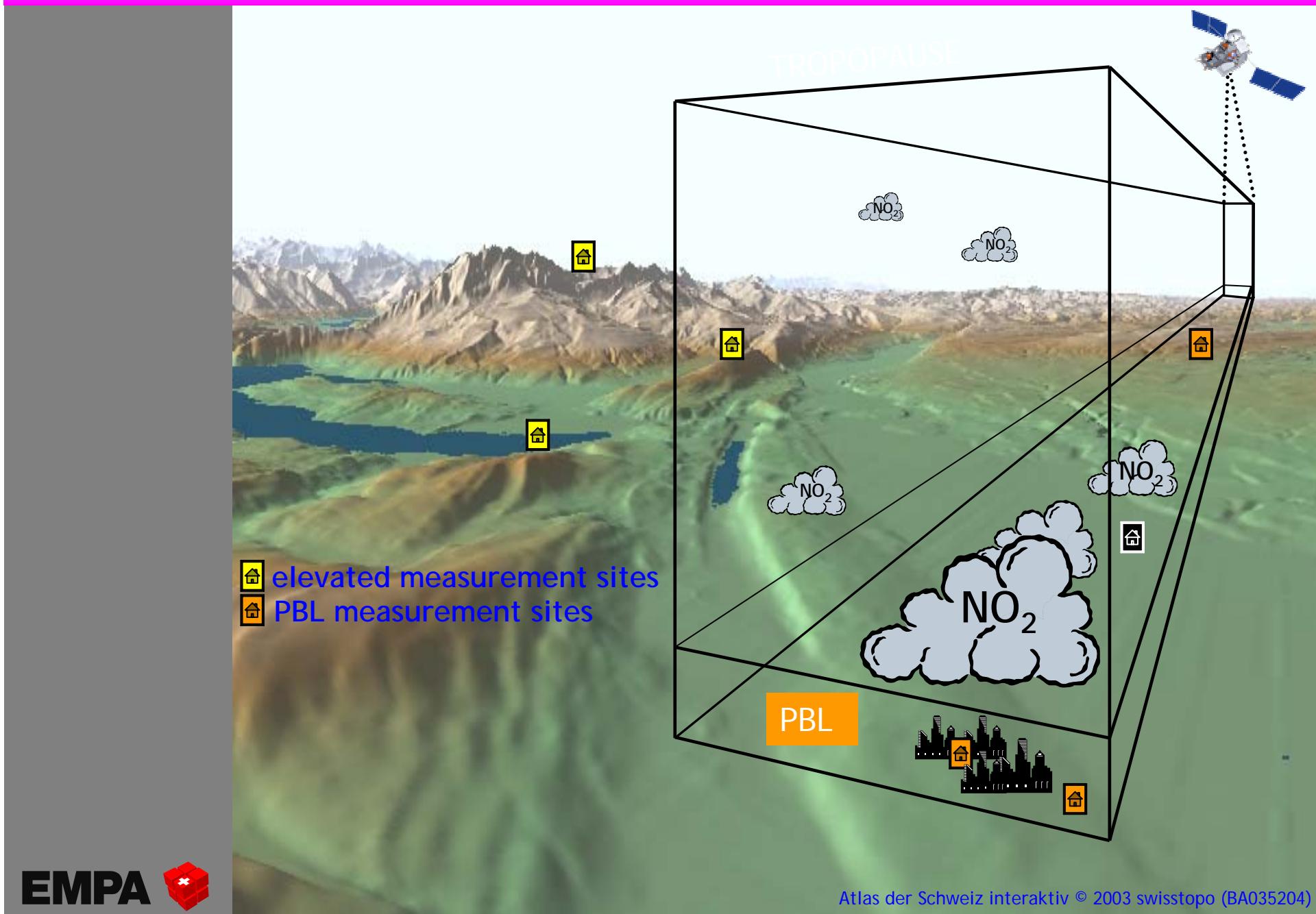
- Offset too large: $3-7 \times 10^{15}$ molec. cm⁻²
- Use boundary layer height to convert conc. → column
- ‘Old’ OMI dataset (new OPF, cloud algorithm improvements)

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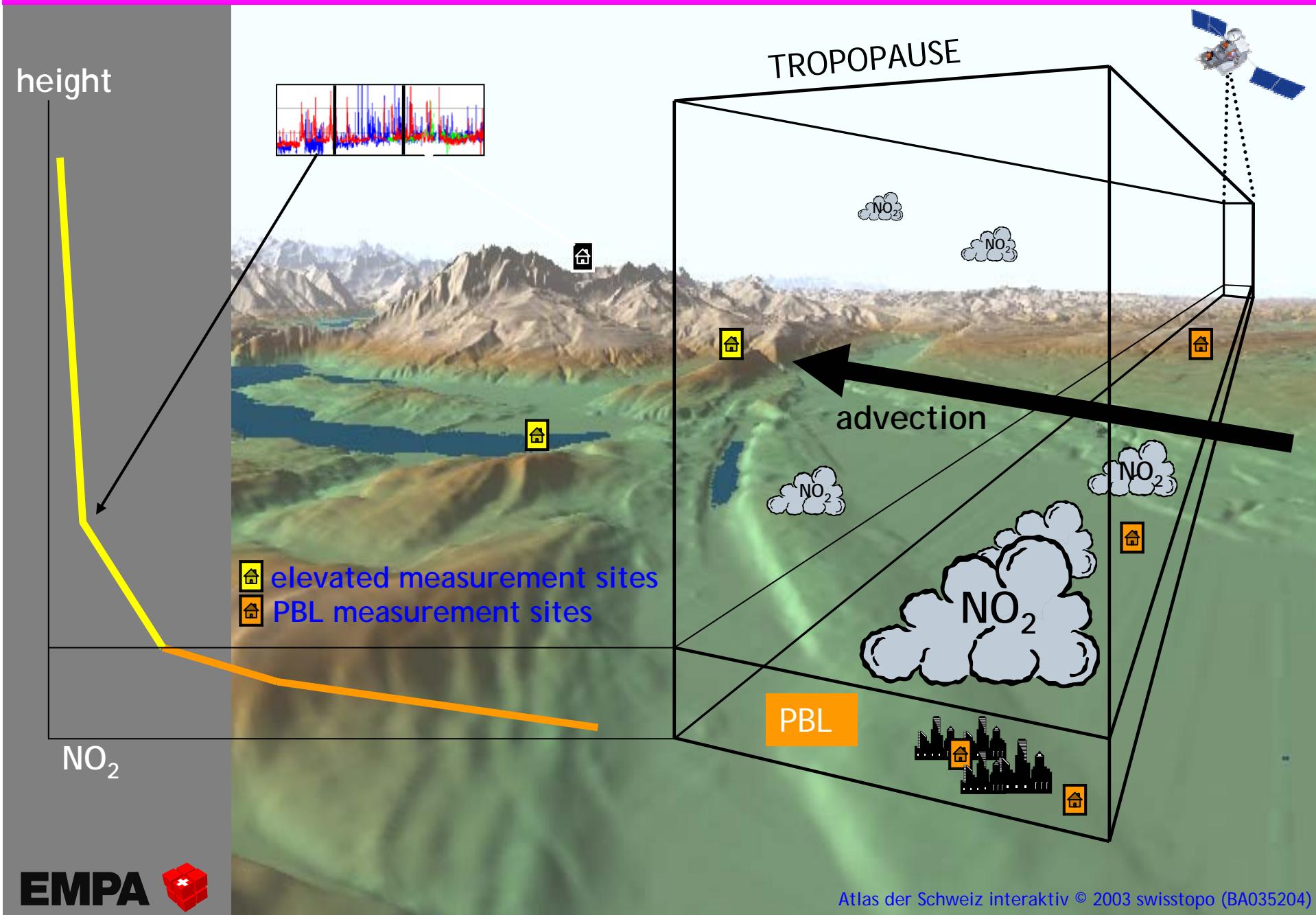
2. Column comparison ground-based in-situ ↔ space-borne



2. Column comparison ground-based in-situ ↔ space-borne



2. Column comparison ground-based in-situ ↔ space-borne



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2. Comparing GOME and in-situ ‘profiles’

GOME:

$$x_S = \frac{N_s}{\cancel{M(\mathbf{x}_a, \mathbf{b})}}$$

Validation:

$$x_V = \mathbf{A} \cdot \mathbf{x}_L \quad \text{with} \quad \mathbf{A} \cdot \mathbf{x}_L = \frac{\sum_l m_l(\mathbf{b}) \cdot x_{L,l}}{\cancel{M(\mathbf{x}_a, \mathbf{b})}}$$

GOME/Validation:

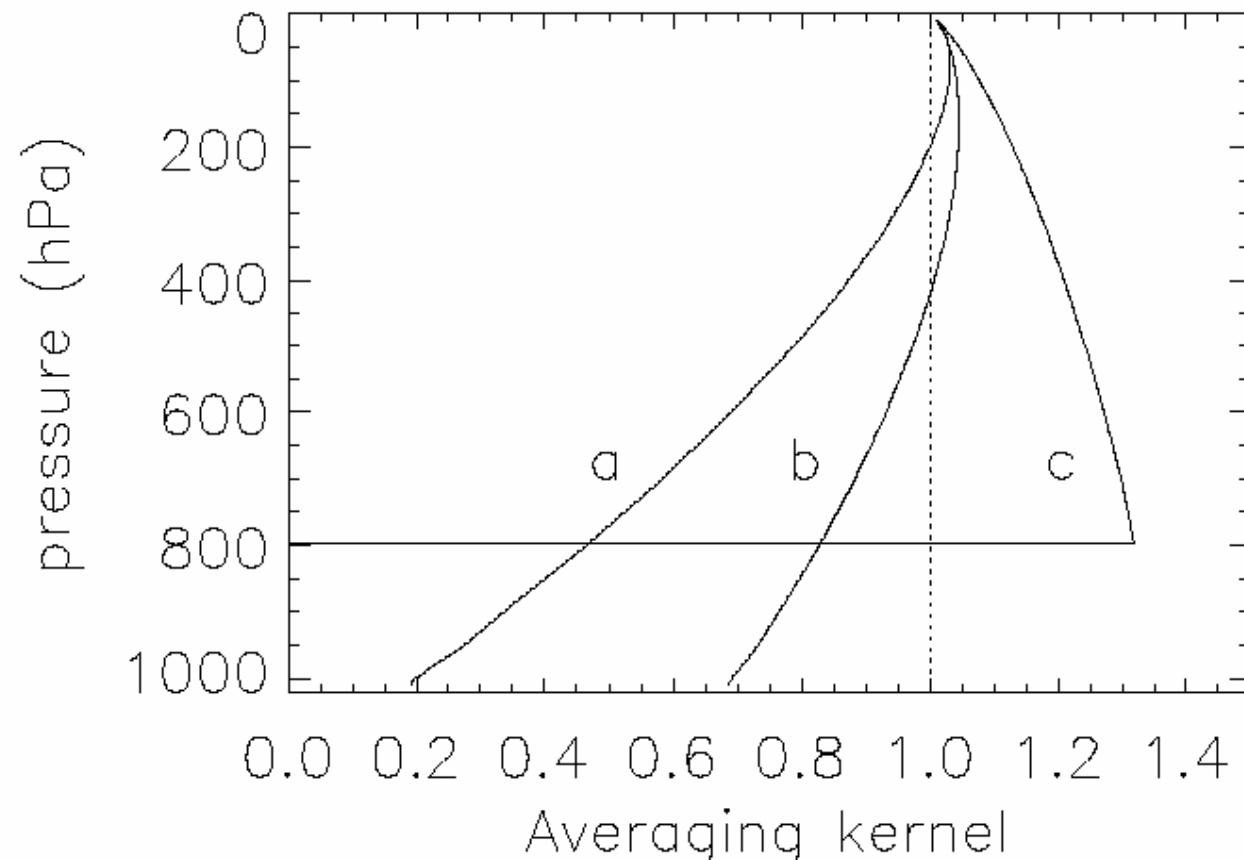
$$\frac{x_S}{x_V} = \frac{N_s}{\sum_l m_l(\mathbf{b}) \cdot x_{L,l}}$$

For every collocation comparison through the kernel

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2. Averaging kernel



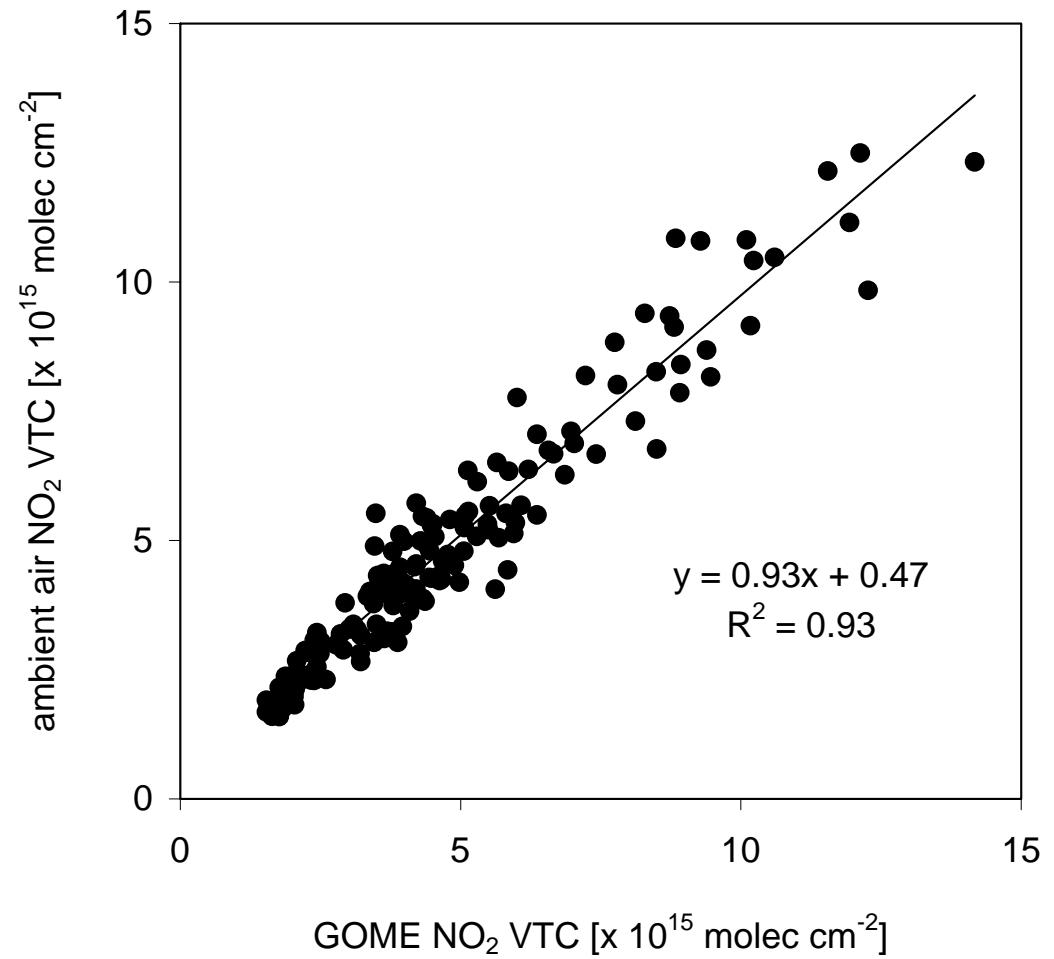
- a) alb = 0.05
- b) alb = 0.20
- c) cloud at 800 hPa

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2. GOME NO₂ validation – cloud-free

- GOME 1996-2003
- Cloud-free scenes
- n~100

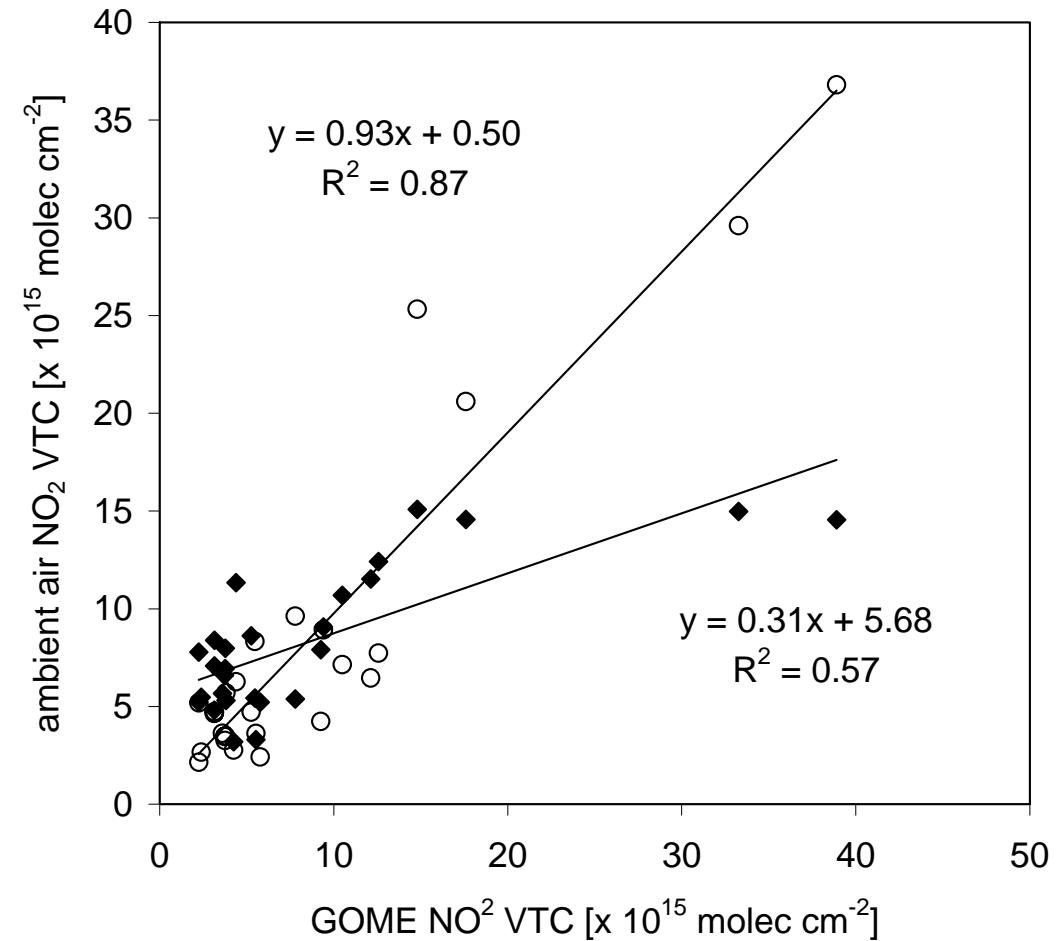


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2. GOME NO₂ validation – cloud-covered

- GOME 1996-2003
- Cloud-covered scenes
- n~25
- open: via kernel
- solid: vertical integral



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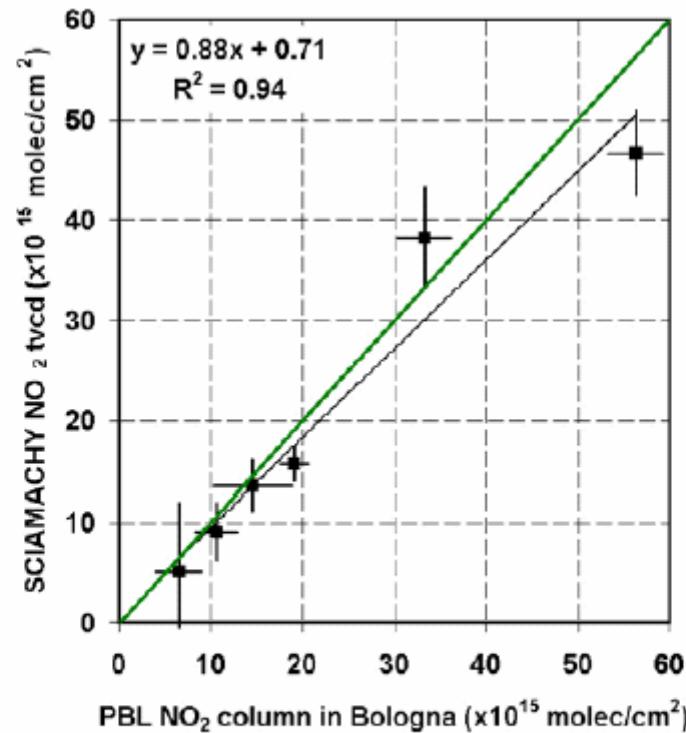
2. Conclusions

- Vertical profiles can be constructed from in-situ ground-based data
- Validation through kernel →
 - Comparison becomes independent on a priori profile
- Preliminary results show excellent agreement
- Representativity issues →
 - What part of difference is caused by differences in temporal/spatial sampling?

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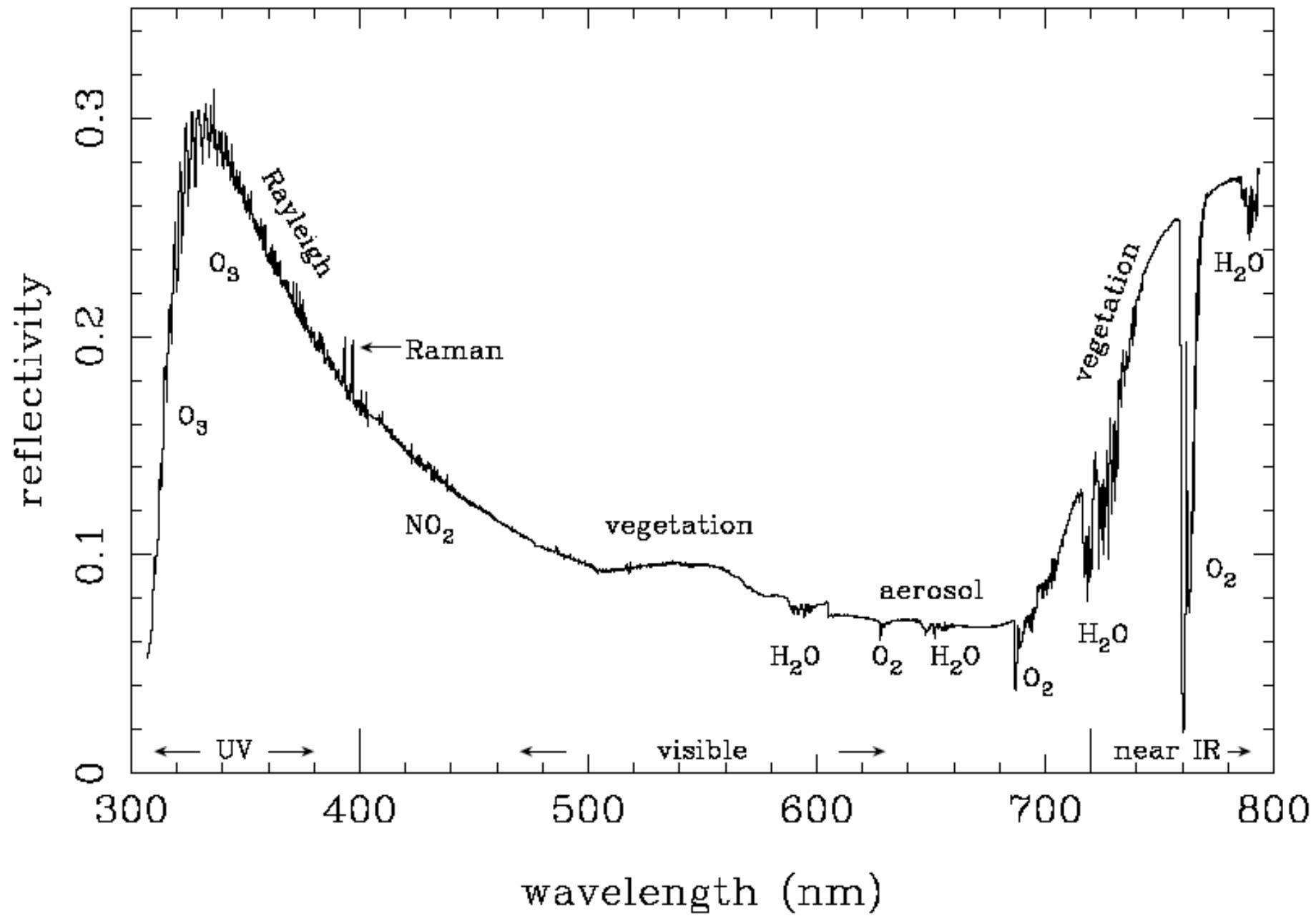
Comparison SCIA – ground-based DOAS Bc



Petritoli et al., 2005

Fig.1: Comparison between tropospheric column measurements of NO₂ obtained by SCIAMACHY and PBL column measurements obtained by GASCOD for some selected days of 2003 after the corrections for horizontal gradient effect.

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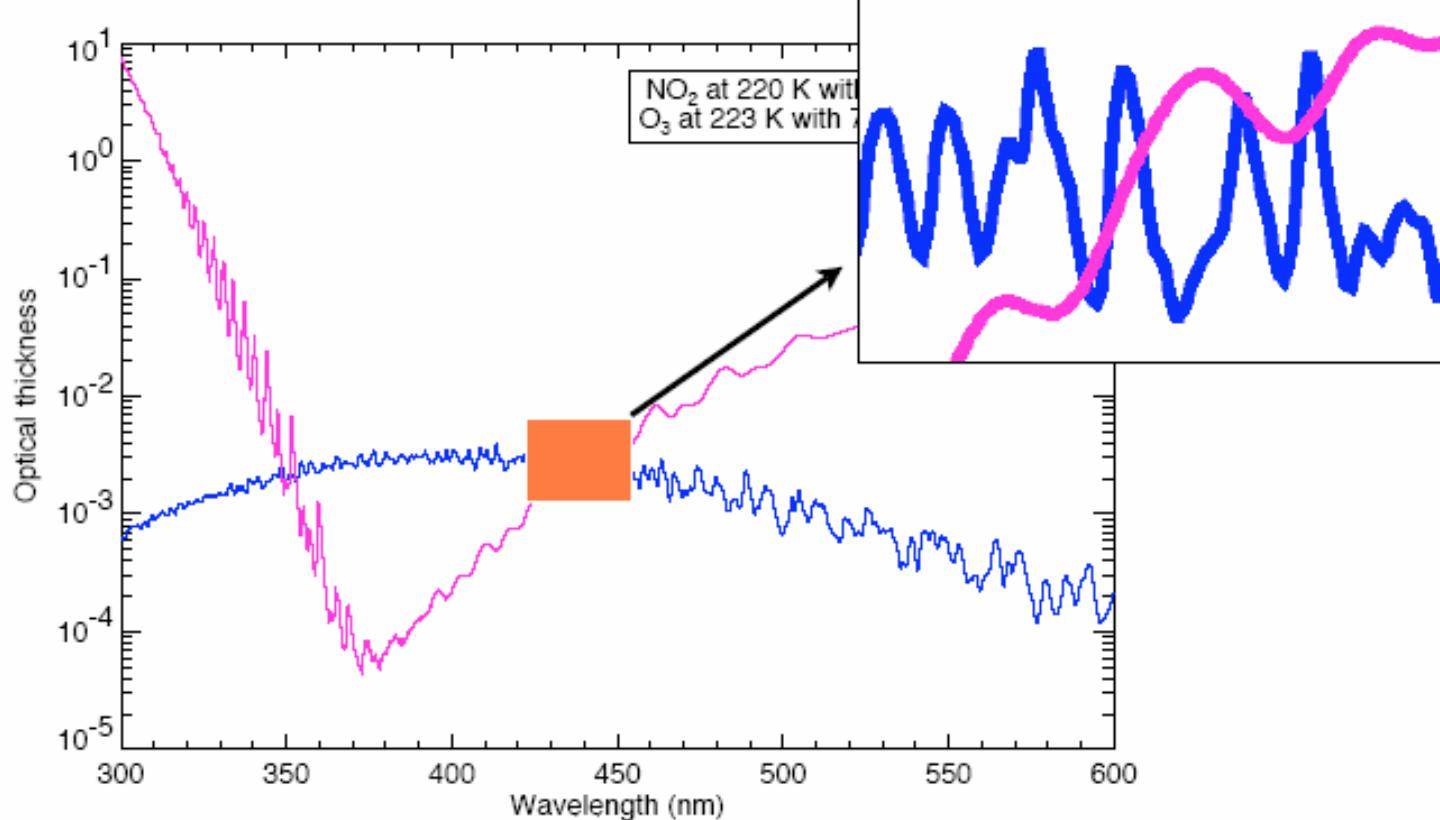


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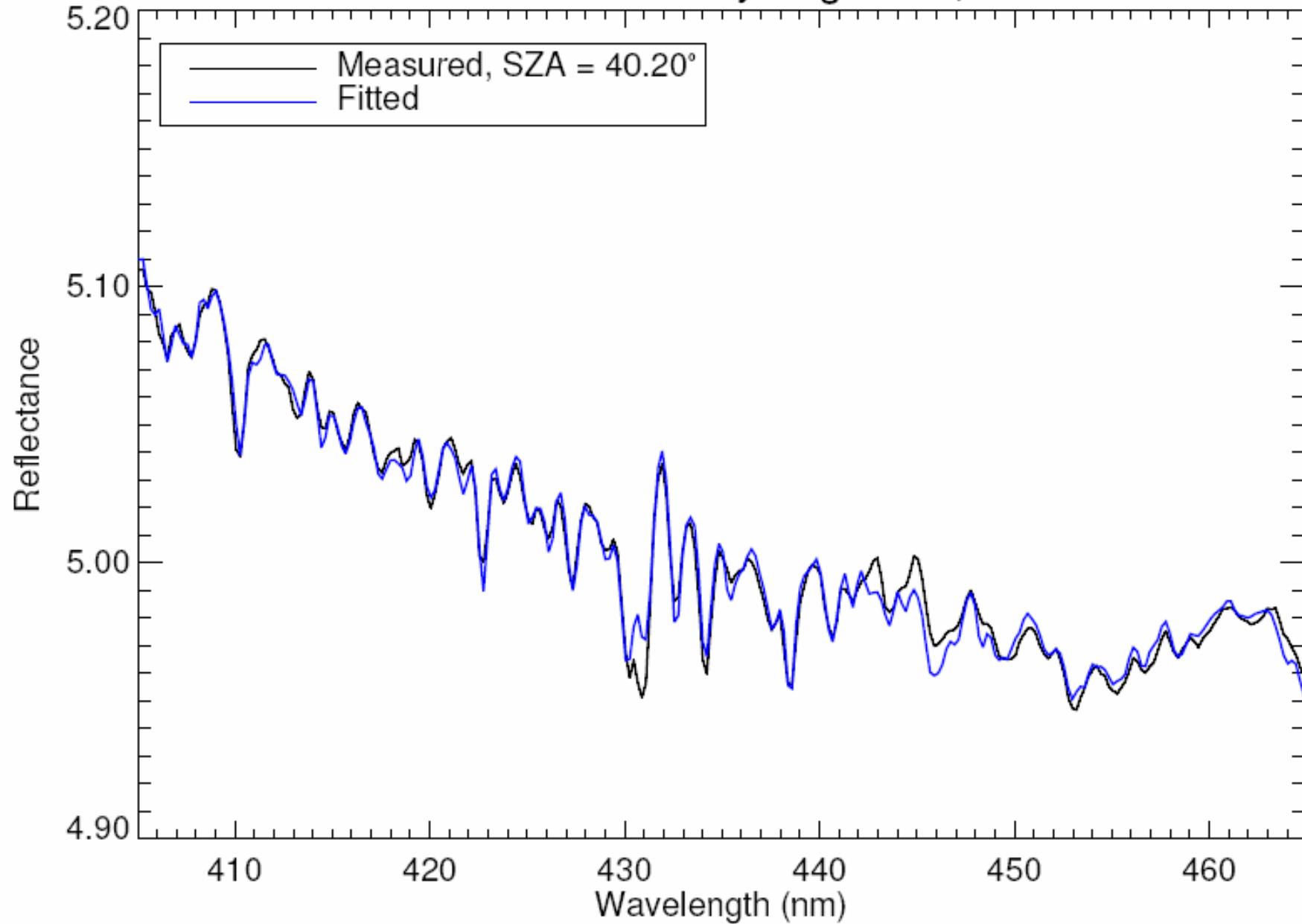
Spectral features at 400°-450 nm



Good signal to noise (~20)

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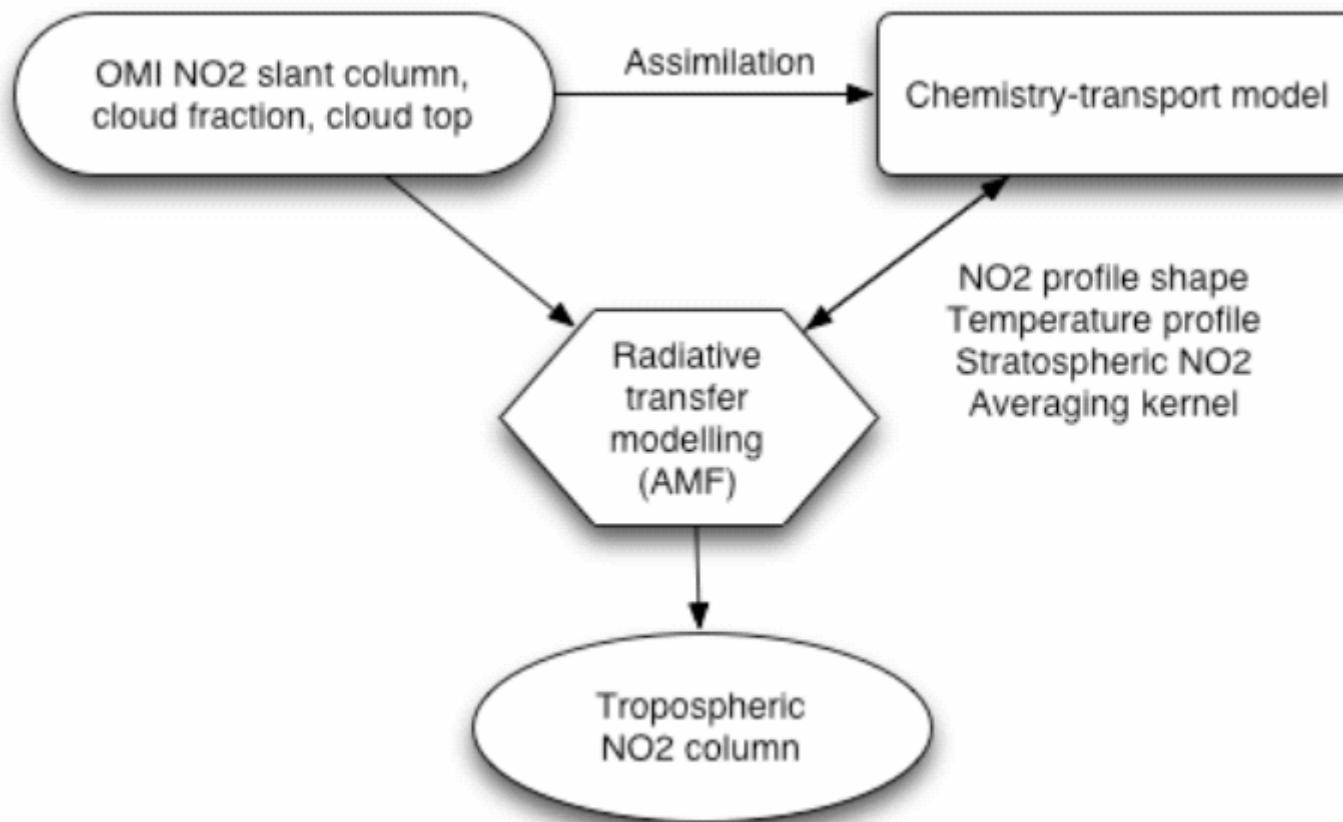
OMI PFM Zenith Sky August 16, 2002



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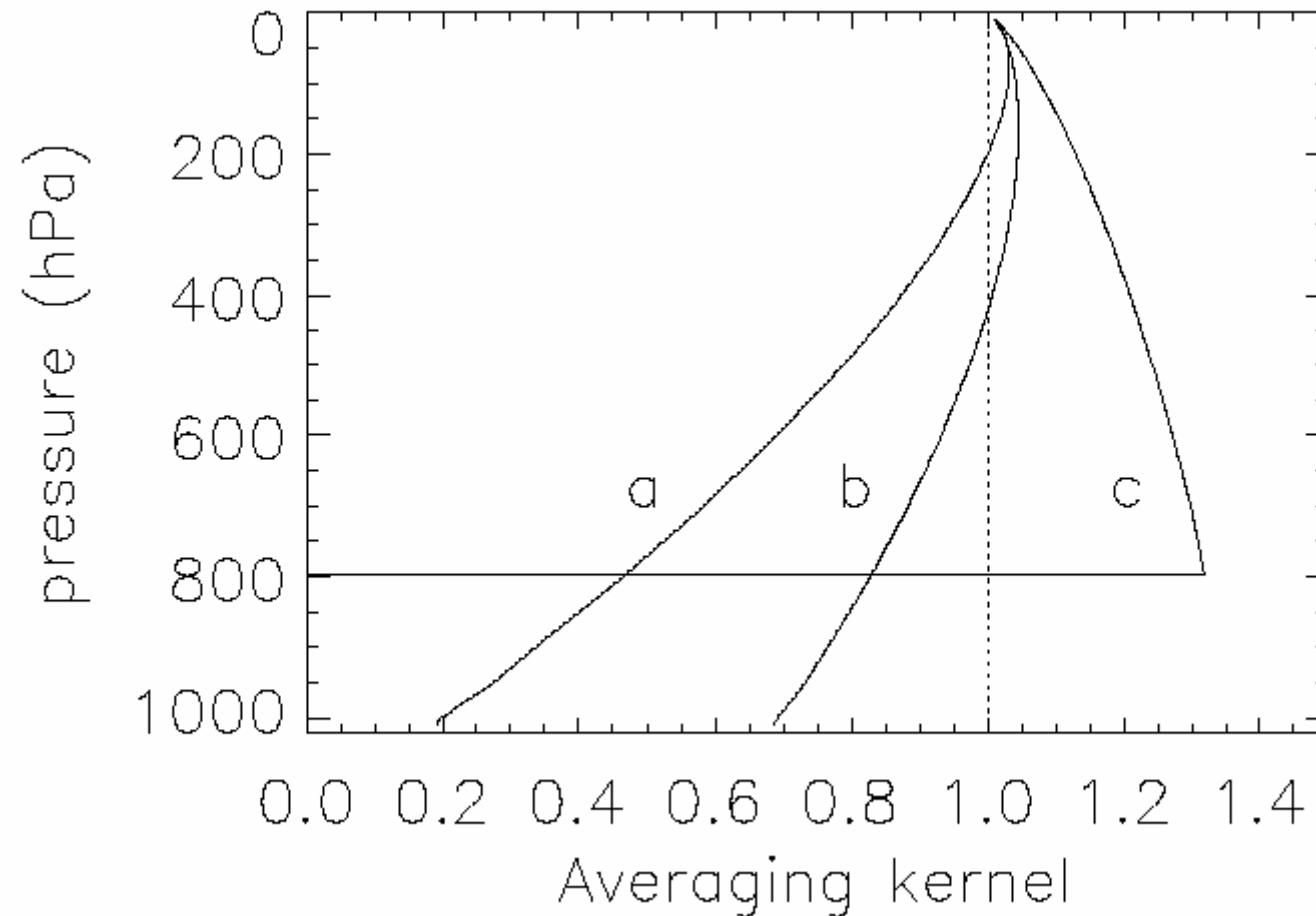
Folkert Boersma, EOS Aura Meeting, 8 november 2005

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